RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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EXTRA-ABDOMINAL AFFECTIONS GIVING GASTRO-INTESTINAL SYMPTOMS, WITH SPECIAL REFERENCE TO THE MENIERE SYNDROME[1]

By A. W. CRANE, M.D., KALAMAZOO, MICHIGAN

THE X-ray has done much to correct the diagnostic errors of misleading symptoms. The reflex effects upon the stomach of diseases within the abdomen have become a commonplace in roentgenological interpretation. The influence of chronic affections of the appendix and gall bladder especially, in the production of stomach symptoms and in the final causation of gastric disease, has made the X-ray investigation of these organs an almost necessary part of a gastro-intestinal examination. But the original view was not roentgenological. Years ago, not far from the time of Roentgen's discovery, William Osler published several remarkable papers on the Visceral Symptoms of the Erythemas and introduced to the American profession the idea of abdominal symptoms without abdominal disease. In the first paper on this subject which was read before the American Roentgen Ray Society, The Stomach as a Reflex Organ (1914), you will find W. J. Mayo quoted as follows: "The stomach is the alarm box of the abdomen and the hose is often turned on the alarm box instead of on the real conflagration." A brilliant paper by La Roque on the same general subject appeared in the *American Journal of the Medical Sciences* at about this date, and from that time on, roentgenological practice was deeply influenced by the reflex idea.

But the production of stomach symptoms by the reflex effects of diseases entirely outside of the abdominal cavity have received very tardy recognition and have entered but little into roentgenological, medical, and surgical diagnoses. This is one reason why cases of abdominal angina, a cardiovascular disease; the visceral crises of the erythemas, skin affections; mucous colitis, a neurosis; and Ménière's disease, an otological condition, continue to be operated upon for supposed appendicitis, ulcer, or gallstones. No one of these is common, it is true, but in the aggregate they assume considerable clinical importance.

The last mentioned extra-abdominal affection giving stomach symptoms is by no means rare and yet is often overlooked, although it presents no especial difficulties in diagnosis—that is, Ménière's disease or the Ménière syndrome. This is possibly because it belongs within the realm of the otologist —one of the specialists "who know more

[1]Read before the Radiological Society of North America, at the Thirteenth Annual Meeting, at New Orleans, Nov. 28–Dec. 2, 1927.

and more about less and less." For many years I have been impressed with the frequency with which cases of Ménière's symptom-complex come in for examination of the gastro-intestinal tract. The dizziness is attributed to some digestive disorder or to the liver and gall bladder, while the nausea, vomiting and perhaps diarrhea seem to confirm this view. Tucker observes, in the new "Tice's Practice": "Often this group of symptoms is attributed to a disordered digestion, the nausea and vomiting attracting more attention than the vertigo."

Physicians themselves when suffering from these spells of dizziness, nausea, and vomiting rarely exercise the personal detachment necessary to disregard the call of the gastro-intestinal tract. The liver and gall bladder are regarded as fellow-conspirators with the stomach. It is a seasickness at home without the bother of an ocean voyage. Instead of hanging over the rail of the ship he hangs over a basin. He stops eating and takes a physic. After the attack he feels fine. He avoids various articles of food. Another attack comes on: then more physic and a stricter diet Finally he asks his friend the roentgenologist to examine his stomach and gall bladder; and the poor roentgenologist, when he has only negative findings to report, knows that a valued friendship and a laboriously built reputation have gone on the rocks together.

This suppositional case is fairly typical in several ways, in symptomatology, in the conviction of the patient that the trouble is digestive or hepatic, and in the disregard of the Ménière symptom-complex by the general practitioner Not all cases, however, are typical or severe and it is not always easy to disentangle concomitant and complicating symptoms. Nevertheless, if looked for, the simple symptom-group will be recognized as making up the Meniere syndrome, namely, vertigo, nausea, tinnitus, partial deafness. In severe cases there will be vomiting, occasionally diarrhea, and, at the height of a spell, a cold sweat. If the eyes are observed, a nystagmus is rarely absent. Turning the head, especially when recumbent, causes marked vertigo. The patient feels sick and incapacitated for business or pleasure during spells, but often, as the deafness of the affected ear becomes total, Ménière symptoms fade away.

"Ménière's disease" and the "Ménière syndrome" are not interchangeable terms. True Ménière's disease is an affection of the labyrinth, usually a hemorrhage into the semicircular canals. If the hemorrhage is sudden, the patient may fall and even lose consciousness for a brief interval. It then is almost indistinguishable from apoplexy. The first spell may be like this and yet later spells be gradual in onset and then be looked upon as gastric. A history of this sort is convincing of intrinsic labyrinthian disease.

But the Ménière syndrome, or symptom-complex, may be caused by many conditions in addition to essential labyrinthian pathology, depending, however, on an involvement of the eighth cranial nerve, which supplies the semicircular canals of the internal ear. Such conditions are syphilis and various infectious diseases, skull fracture, brain tumor or abscess, certain drugs, including alcohol and nicotine, and finally, most important, toxemias and focal infections. The diagnostic chain thus becomes complicated and often obscure but the fact remains that the resulting symptom-complex is almost uniformly attributed to the gastro-intestinal tract or the gall bladder.

Concerning syphilis of the eighth nerve, Isaac Jones states: "It is a common experience among otologists to find that a large percentage of syphilitics in various stages of the disease show an impairment of the labyrinth and the eighth nerve." Therefore, nausea, vomiting, vertigo, loss of appetite, inability to eat, in conjunction with a four-plus Wassermann is likely to mean, not

syphilis of the stomach, but the Ménière syndrome due to a syphilitic involvement of the eighth nerve or labyrinth. The roentgenologist who tries to find changes in the stomach contour or peristaltic behavior in what he believes to be gastric lues may be disappointed by negative findings. The persistent vomiting in syphilitic cases may ultimately bring blood in the vomitus and cause epigastric soreness and pain, all of which may lead to the erroneous conclusion that a stomach lesion is present. This, of course, does not preclude true syphilitic involvement of the stomach, which is, however, more rare than formerly believed.

If toxemias may produce Ménière's symptom-complex, then why may not an intestinal toxemia be a cause? If this were true, then in some cases at least the primary cause of the vertigo, nausea, and vomiting would be precisely where patients think it is. Granting that this were true, we would still have to exclude from this category, cases with a partial deafness of one ear or any intrinsic ear disease or other sources of toxemia, and infection. But it is extremely doubtful if intestinal toxemia does give rise to anything more than the moderate dizziness of a bilious attack, because the true Ménière syndrome is not relieved by calomel, cathartics, repeated enemas, or, as a rule, by any arrangement of the diet. Moreover, indicanuria, which is the index of intestinal autointoxication, is not a feature of the Ménière syndrome. In this connection Stockton, in *Oxford Medicine* (IV), says: "Since the time of Trousseau certain cases of vertigo have been attributed to the gastro-intestinal tract. From Continental writers come the majority of cases reported. Admittedly, when from gastric or intestinal reasons there arises intoxication, cerebral symptoms, among which is a moderate vertigo, present themselves. Few American clinicians consent that gastro-intestinal vertigo is a distinct clinical entity."

Isaac Jones states: "Toxemias which produce definite impairment of the internal ear include also the repeated assaults of a milder toxin, such as those from the gastro-intestinal tract or from a focal infection." However, his case report mentions only fish and egg, from which we judge that the effects were due rather to proteid sensitization than to intestinal toxemia. Yet the result of a focal infection in certain cases is beyond question. Here we believe it is a bacterial invasion rather than a toxemia, and is in no way different from the production of an arthritis.

When vertigo, nausea, and vomiting suggest a gastro-intestinal cause, the auricle and external canal of the ear may be examined. Once in a lifetime you may find there a patch of herpes, in which case you have Hunt's syndrome. Tinnitus, partial deafness, and nystagmus will also be found. Occasionally a facial paralysis co-exists with a slight fever and neuralgia. This syndrome was described by James Ramsay Hunt in 1907 and is due to an involvement of the geniculate ganglion. It is a combination in miniature of tic douloureux and herpes zoster and is an exquisite example of the reflex chain.

The artificial production of the Ménière syndrome by Bárány's methods is a most conclusive demonstration of the origin of this symptom-group. Bárány showed that by douching the auditory canal and tympanum with cold and hot water he caused surges in the endolymph of the semicircular canals and induced intense vertigo, nausea, vomiting, tinnitus, and nystagmus. Whirling tests, head motions, and electrical stimulation, setting up similar movement of the fluid in the semicircular canals, produced like symptoms. The true nature of seasickness was thus uncovered—the motions of the ship causing movements of the endolymph for which the unaccustomed sailor is unable to compensate. It became clear

also that there is a close relationship between the Ménière syndrome and sea-sickness. In fact, they are identical—one caused by the motions of a ship and the other by disease. Persons who are totally deaf cannot be made sea-sick and are also safe from Ménière's syndrome. Is it any wonder that a symptom-group which simulates sea-sickness so curiously should be attributed by sufferers to the digestive system, and that a distant organ like the ear, whose sole function, in the popular mind, is hearing, should never be suspected as a cause of such severe symptoms? Yet we know that even a little cerumen impacted upon the ear drum may lead to a gastro-intestinal examination.

Bárány's conclusions are universally accepted by authorities. His water tests and whirling chair have become indispensable in arriving at an otological diagnosis and in testing aviators. In 1915 he received the Nobel Prize in recognition of his achievements. His explanation of the association of vertigo, nausea, and vomiting with disease of the labyrinth and the eighth cranial nerve is no longer disputed.

According to the best otological authorities vertigo is exclusively an ear phenomenon. No matter from what source—whether the eye, the cerebellum, the cardiovascular system, etc.—yet it is the effect upon the organs of equilibrium in the labyrinth that produces the vertigo. Jones is emphatic upon this point: "If the same pathologic cause for one reason or another fails to irritate the ear or its nerve distributions, *there will be no vertigo.*"

It appears that we must give up vertigo as a gastro-intestinal symptom, but the nausea and vomiting remain as the reflex gastro-intestinal symptoms of the Ménière disease or syndrome. If these are associated with tinnitus, nystagmus, vertigo, partial deafness or any disease of the ear, then we have a logical explanation of negative X-ray findings of the gastro-intestinal tract and gall bladder.

To suggest an adequate reason for negative X-ray findings may be a defense reaction on the part of the roentgenologist. If he has not found the trouble, it is because he does not know how—that is the attitude of some patients and occasionally of some surgeons. Negative X-ray findings may be the outcome of some of the finest work in roentgenology and yet a patient may sum up the whole painstaking investigation with contemptuous brevity in the oft-heard remark, "Oh, they found nothing!" It is allowable, therefore, for the roentgenologist, after negative X-ray findings in the type of case under discussion, modestly to make the statement that the negative character of the findings directs attention to the internal ear.

It may be objected that the duty of the roentgenologist ends with his report of findings. It is quite right for any one of you to take this attitude if he so chooses. But it is a distinction from the technician that the roentgenologist is a diagnostician and a consultant with the internist or surgeon. In this capacity he may discuss the case with such professional diplomacy as he possesses and suggest further lines of examination in the cases in question; namely, those with Ménière's syndrome in view. It is certainly to the good of the patient that he should bring up the question of focal infection and other causes, and perhaps suggest the X-ray examination of the sinuses, teeth, mastoids, and skull in general.

Study negative findings: it is in this field that future X-ray discovery may be expected. Hardly less important is the fact that behind every negative finding, at apparent variance with symptoms, lies a worth-while diagnostic problem. If the roentgenologist will but exercise his training in the general diagnosis of internal disease, then perhaps there will be increased precision in the application of X-ray methods and fewer

examples of the examiner being lured into unproductive territory by the symptomatic mirage so perfectly illustrated in the Ménière syndrome.

DISCUSSION

Dr. James T. Case (Battle Creek, Mich.): Dr. Crane as usual has given us much food for thought. I wonder if we all appreciate the real value of the series of communications which Dr. Crane has been giving us year by year. He typifies the ideal towards which every radiologist may work, for he combines with his radiological work as broad a clinical experience as is possible for him to obtain. He once more emphasizes the fact that the stomach is the alarm box of the abdomen. We see this demonstrated often. I recall particularly how many gall-bladder patients say, when surgery on the gall bladder is proposed, "Doctor, I did not come here for my gall bladder. I came here for my stomach." Of course, we have to explain to them that the stomach is the alarm box.

Abdominal angina is a possible diagnosis we should always have in mind. When there is any possibility of such a diagnosis, it is well to make a lateral roentgenogram of the lower dorsal and lumbar spine. The chances are that in a case of abdominal angina we will find in front of the spine some plaques of calcification placed parallel with the spine, which represent calcification in the aortic wall. I was recently called in consultation on a case of this kind where the X-ray examination furnished the decisive information.

Dr. M. J. Hubeny (Chicago): I have not much to say except to verify some of the remarks you have heard. However, when you are dealing with this part of the anatomy you should not be led into a hasty conclusion unless you are really convinced that the radiological findings fit in with your clinical diagnosis. The first time I heard Dr. Crane was about fifteen years ago, and even at that time he emphasized the desirability of a clinical survey and aspect of each case. I heartily agree with him, as that is our prerogative as doctors of medicine.

Dr. Robert H. Lafferty (Charlotte, N. C.): There are between twenty and thirty feet in this alimentary tract of which we hear very little. It is a pleasure for me to hear these essayists, as they leave the stomach and begin the study of the small intestine. In a study of the alimentary tract, after leaving the first portion of the duodenum, we find very little in the X-ray literature until we reach the colon. I have longed for the time when some man, who has the opportunity, would make a detailed study of the small intestine. Why should there not be some pathology here? Why should we not be able to demonstrate it? Up to date the occasional diverticulum or adhesion is about the extent of our findings in this area.

Dr. Crane (closing): I will take only sufficient time to get two points on duodenal stasis before you.

One is that duodenal stasis may result from a non-obstructive lesion in the small intestine when that lesion is cancer. Such a lesion will give, at the same time, a prolonged gastric retention, sometimes exceeding twenty-four hours, with a sustained inhibition of peristalsis.

The second point is that an ulcer of the duodenum below the bulb, although only slightly obstructive, yet causes a marked dilatation of the duodenal loop because of very rapid initial expulsion of barium through the pylorus by active gastric peristalsis, in marked contrast to the reaction to a cancerous lesion in the same location.

After this initial engorgement of the duodenal loop there is also an inhibition of peristalsis with a dilated duodenal loop.

Both cancer of the duodenum and duodenal ulcer below the bulb are exceedingly rare and so of relatively small clinical importance, yet the roentgenologic contrast is interesting.

Bronchography: Introduction of Iodized Oil into the Tracheobronchial Tree by the "Passive" Method. Alton Ochsner and Wellwood Nesbit. Am. Jour. Med. Sci., February, 1928, CLXXV, 175.

When food enters the larynx, the reflex act of swallowing is instituted, the pharyngeal muscles contract, the larynx becomes elevated to a point of safety, and the tonically contracted esophageal orifice becomes relaxed. If a sensory anesthesia of that portion of the pharynx is produced, a substance passing into the pharynx will not initiate the reflex of swallowing. This is done by cocainizing the anterior faucial pillar. Following the anesthesia the oil can pass in the only remaining opening, the larynx. It is essential not to anesthetize the pharynx too completely, as relaxation of the esophageal orifice can thus be produced. Bronchography is most useful in the early obscure pulmonary conditions and early chronic conditions, such as chronic bronchitis, recurrent bronchitis, and bronchiectasis. The authors report three cases and stress the point that bronchography, in addition to its diagnostic value, has a distinct therapeutic effect, and recommend repeated introduction by the passive method. This procedure is not objected to by patients. In a series of over 700 cases, no untoward signs or symptoms have been observed.

R. A. Arens, M.D.

OBSERVATIONS ON THE MOVEMENTS OF THE DUODENAL CONTENTS, WITH SPECIAL REFERENCE TO ANTI-PERISTALSIS AND PYLORIC REGURGITATION[1]

By R. W. A. SALMOND, M.D., Ch.M., D.M.R.E.,

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THE duodenum is usually considered as consisting of three parts, the first or cap, the second or descending, and the third or ascending limb. The curve or angle formed by these is subject to much variation in different subjects. Developmentally, the cap, like the stomach, arises from the foregut and resembles the stomach rather than the rest of the duodenum in both its outline and behavior—from the radiological—and in its interior from the anatomical, the medical, and surgical points of view.

In a paper (1) published in the *Lancet* last year in conjunction with Dr. C. Bolton, antiperistalsis was described as a normal movement of the duodenum, and its clinical significance discussed. I now record further observations on the movements of the duodenal contents made by means of X-rays.

The movements of the small intestine as a whole have been more or less known for many years but those special to the duodenum have received less attention. This may be because it has been taken for granted that the movements of the duodenum are the same as those of the rest of the small intestine.

Barclay (2), in 1915, thought the shape of the cap "suggests an auxiliary sphincter, holding a small supply of food to keep an even flow into the second part of the duodenum." He also stated that if the meal could be seen clearly in the duodenum after leaving the cap, the case was one of a class he styled "duodenal irritation." It should perhaps be pointed out that the observations were made at a time when his meal consisted of a comparatively small quantity of bismuth food made with bread and milk. Case (3), in the same year, described the motor behavior of the normal duodenum and was then of the opinion that reverse peristalsis was frequently seen. Much of the published work has been on the pathologic duodenum; the present paper is intended rather to deal with the normal duodenum, it being thought that a clear conception of this will help in the appreciation of the abnormal.

The following observations were made in opaque meal examinations, with special attention to the duodenum and pylorus, no aperient having been taken during the previous 36 hours. The meal consisted of four to six ounces of barium sulphate held in suspension in a pint of malted milk at body temperature, its passage being watched through the stomach and duodenum with the patient in varying positions. It is fully realized that this is not a natural meal, but some substance opaque to X-rays is necessary for this method of investigation. It is also believed that neither the quantity nor the consistence of such a meal causes irritation of the stomach or duodenum. It may be said at once that the movements of the duodenal contents are not only very complex, probably more so than in any other part of the alimentary tract, but also subject to variation in different subjects. In thick persons it was often impossible to see clearly enough to make observations, and the

[1]Paper read before the Electro-therapeutic Section, Royal Society of Medicine, London, April 27, 1928.

best results were obtained with thin ones, when the movements inside the duodenum could be seen in detail. Even in some of these the position of the second and third parts of the duodenum was such that it was impossible to make observations. The following is a summary of what has been observed of the movements of the food in the normal duodenum after the age of infancy:

1. Peristalsis and antiperistalsis of the cap, usually called contraction of the cap.
2. Peristalsis and antiperistalsis of the second and third parts.
3. Segmentation or mixing movements of the second and third parts.
4. Forward movements *en bloc* due to the downward inspiratory movement of the diaphragm, especially affecting the second part.

These have been seen, not only in normal cases but also in the various pathologic conditions of the stomach, duodenum, appendix, and gall bladder.

1. *The cap*, or first part of the duodenum, appears to act as a reservoir, and to have two functions or phases, a passive and an active one.

(a) The passive phase is seen when a gastric peristaltic wave propels the food through the pylorus, fills the cap, and apparently also forces the food on to the second part of the duodenum without any visible contraction on the part of the cap. Another example of this phase is seen when the filled cap is lying above the pylorus and suddenly a narrow stream of opaque food is observed to flow back into the stomach without any visible contraction on the part of the cap, there being a relaxation of the pylorus and the absence of a gastric peristaltic wave in the pyloric antrum (Fig. 1).

(b) The active phase.—As the cap becomes filled by gastric peristalsis, or, as will be described presently, by antiperistalsis in the other parts of the duodenum, it contracts at irregular intervals and the food passes for the most part into the more distal parts of the duodenum or to a much less extent into the stomach. The contraction may expel the whole of the cap contents or only that in the more distal part, the contents in the part nearest the pylorus remaining. No definite relation has been observed between the cap contraction and the gastric peristalsis.

The nature of the cap contraction is without any doubt a muscular one on the part of the cap itself. A wave of contraction starts either at or near its base and proceeds forward (peristalsis), or toward its distal end and travels backward (antiperistalsis). *This observation is best made in cases with* a long-drawn-out cap. Whether the cap contraction expels its contents onward into the other parts of the duodenum or backward into the stomach depends on different factors, the patency of the pylorus, the relative pressures in the cap and in the stomach at the time, and also whether the contraction wave started at the proximal or distal end.

2. *Peristalsis and antiperistalsis in the second and third parts.*—When the food is propelled by the cap or the stomach into the second part it may lie there a few seconds or it may be at once driven farther on by a peristaltic wave. At times, this wave drives it onward only a little; at other times, it may propel it into the jejunum without the slightest delay at the duodeno-jejunal junction, and I am of the opinion that there is no definite sphincter action at this situation in normal cases. The writer has observed, however, some holding up here in a case of "leather-bottle" stomach, when the function of the pylorus was lost, as if the duodeno-jejunal flexure were trying to act as a substitute. Peristalsis is usually believed to involve a contraction of the gut muscle at one part with a relaxation farther on, and there is nothing special in the peristalsis of these parts of the duodenum as compared with that of the rest of the small intestine.

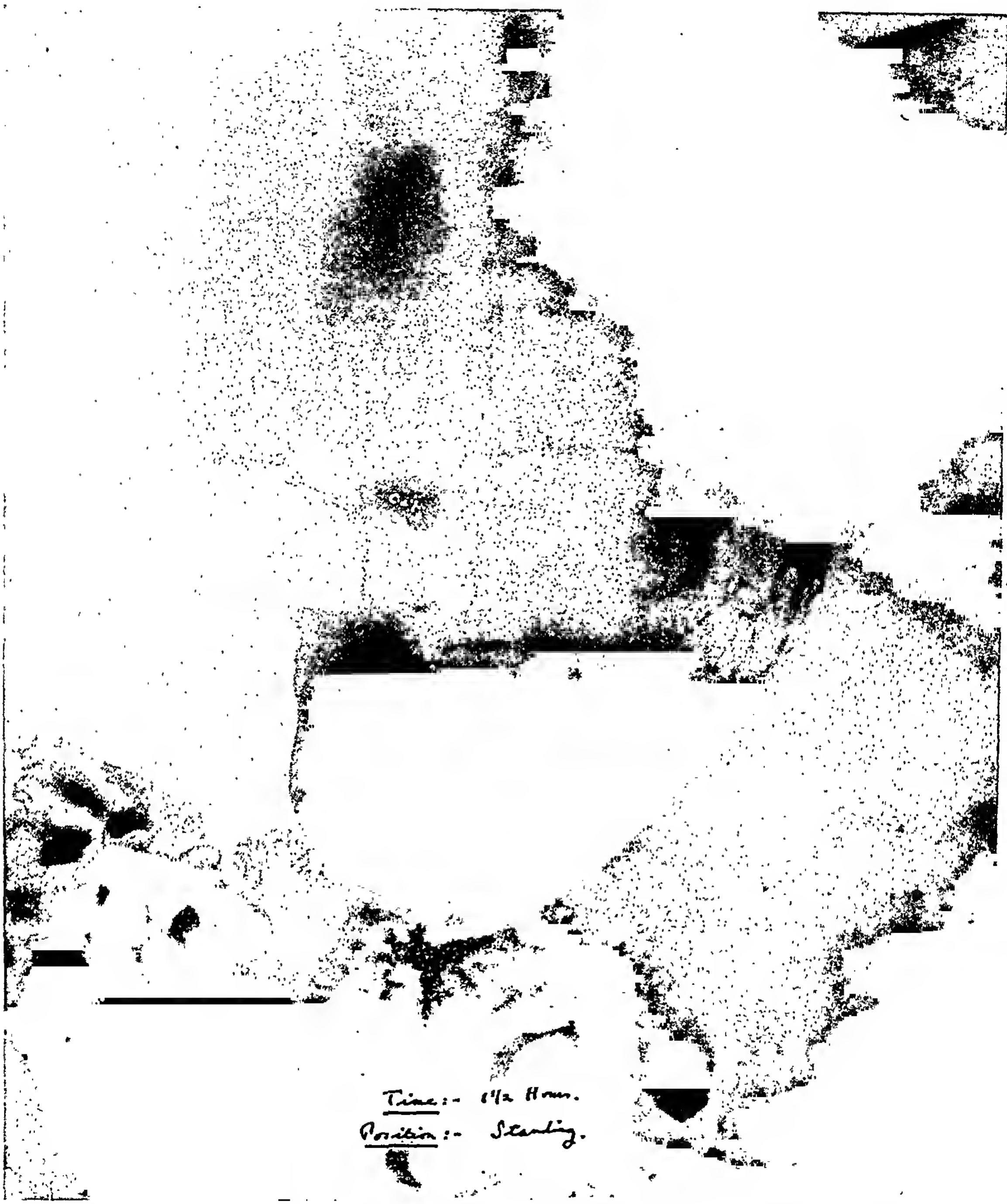

Fig. 1. Note the narrow stream of barium connecting the cap with the barium in the stomach. The air-lock at the pyloric end of the stomach shows that the stream is not being propelled from the stomach into the cap.

Often, however, before the peristaltic wave or waves can propel the bolus into the jejunum, a contraction wave in the opposite direction is set up, and the food mass is driven backward into a more proximal part of the duodenum or into the cap or even into the stomach. The radioscopic appearance of this wave is similar to that of the peristaltic

wave except that it is in the opposite direction, and if the forward movement of the food is called "peristalsis," the backward movement seems equally entitled to be called "antiperistalsis." It may be said here that these waves are quite distinct from segmentation, which does not drive the food one way or the other but merely breaks it up. If this backward wave has filled the cap, a contraction of the cap is set up sooner or later and the food, along with any that has been meanwhile expelled from the stomach, is again driven forward into the second or third parts. In this way successive boluses of food are thoroughly mixed together and with the digestive juices. No definite relation has been observed between gastric peristalsis, duodenal peristalsis, and antiperistalsis. It is usual for the peristaltic waves to be more frequent than the antiperistaltic, as might be expected. Antiperistalsis in the second and third parts may drive the food through the cap and pylorus into the stomach, depending on the patency of the pylorus and the relative pressures in the duodenum and the stomach.

It seems, however, that antiperistalsis in the second and third parts of the duodenum is not the only factor in pyloric regurgitation, but that this can be produced, as mentioned above, by the cap in its contractile function, or it may occur in its passive phase, the necessary conditions being favorable (namely, relaxation of the pylorus, and the intraduodenal pressure higher than the intragastric) Marbaix (4) registers a duodenal pressure of 10 cm. to 15 cm. water, and Payne and Poulton (5) found the mean pressure in a normal person to be 14 cm., with rises to 18 to 20 cm. With a relaxed pylorus these pressures are sufficient to overcome the mean intragastric pressure, which is normally below 10 cm of water; since, however, with a peristaltic contraction of the stomach the pressure in the pyloric end rises to 20 cm. or 30 cm. of water or even higher, pyloric regurgitation would be impossible at such a moment. Pyloric regurgitation is now recognized by many authorities as a physiologic process, and from these observations appears to take place in two ways: *(a)* antiperistalsis in the second and perhaps the third and first parts of the duodenum concurrently, and *(b)* a more slow trickle through the pylorus when that is relaxed. In a series of 100 consecutive cases specially observed, antiperistalsis in the duodenum was observed in 93, and has now been seen in over 300 cases. The actual regurgitation through the pylorus into the stomach has been seen in only some 20-odd cases. Without doubt this small number is due to the very great difficulty of detecting the narrow opaque stream in the pyloric canal, or, if detected, knowing with certainty in which direction it is passing. In stout subjects it is useless to attempt to make observations on this point.

The movements of the duodenal contents which have been described may help to explain the cause of the symptoms and the results of tests of some of the functional disorders of the stomach and duodenum, and also aid in their treatment. The acidity of the gastric contents appears to be of secondary consideration, for as long as the sphincter acts normally the amount of gastric juice secreted is of little moment. It is, therefore, of importance that the exact movements of the duodenal contents and the part played by the pylorus in the process of their regurgitation into the stomach should be made clear.

3. *Segmentation or mixing movements in second and third parts* are visible as worm-like movements, between the more violent peristalsis and antiperistalsis, breaking up the mass of food into small particles. Their function seems to be that of mixing the broken-up food with the digestive juices, and not to be in moving the food onward or backward. They are known

to occur in the rest of the small intestine and do not appear to have any special characteristics in the duodenum.

4. *Movement "en bloc."*—When the diaphragm descends on full inspiration there may be seen at times a downward movement of the contents in the whole of the second part, as if the pressure of the diaphragm were acting against it and forcing the food forward into the third part. This is not a movement of the duodenum itself but rather an extraneous factor, and as it appears to have at times some effect in helping the passage of the duodenal contents onward, has been included.

These observations are recorded as a slight contribution to a subject upon which diverse opinions are held. Duodenal antiperistalsis is undoubtedly frequently observed and the crux of the problem would appear to be the evaluation of its significance. Is it (*a*) a normal process, or (*b*) is it due to the abnormal meal, or (*c*) is it merely one of the radiologic signs of duodenal irritation, stasis, or obstruction, or delay even farther on? The writer is inclined to favor the first for the following reasons: *(a)* The large percentage of cases in which it has been observed when carefully looked for, many of the cases being "normal" subjects; *(b)* it is also seen when small meals are given, and in the upright, the supine, and the prone positions, and (c) it is seen during all stages of the stomach emptying and with no delay in the complete emptying of the duodenum.

Finally, I wish to express my thanks to Dr. Charles Bolton for his great help from the clinical aspect. Upon his suggestion many of these observations were made.

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THE VALUE OF SYNCHRONIZATION IN ACCURATE DIAGNOSIS OF CHEST DISEASES[1]

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SYNCHRONIZATION as applied to chest radiography means making exposures at a selected phase of the cardiac cycle. When exposure is sought at the time of closing of the heart valves, it is possible to listen for the sounds, to catch their rhythm and close the X-ray switch at the instant the sound begins. Meek and Eyster (1) in their pioneer work used this method, checking their timing by means of an electrocardiogram. In this way they were able to record the heart immediately before and immediately after systolic discharge, and to estimate cardiac output from the difference in size of the silhouette.

Attempts by one of us to amplify the heart sounds (2) microphonically and to use the amplification to close the X-ray switch failed because extraneous sounds, or movements of the patient, would produce sounds sufficient to activate the apparatus.

The pulse wave, which affords an impulse with a definite relation to the cardiac cycle, has been employed as the source of excitation in the Weyl pulse relay (2). A cannula, applied over the carotid artery, transmits the pulse thrust to a tambour, against which is suspended a tiny mirror. On the mirror an intense beam of light falls when the tambour is moved by the pulse wave, and the reflection is thrown into the eye of a photo-electric cell. The current of the photo-electric cell is amplified through specially designed vacuum tubes, and may be used to close the X-ray switch. Modification of an X-ray exposure timer to serve as a lag timer allows one to make the exposure at any desired interval after the pulse wave has passed

Pairs of films that are synchronized so as to be exposed in the same phase of the cardiac cycle are truly stereoscopic. By synchronization with late diastole, films may be made at a time when cardiac movement is at a minimum. This is the most satisfactory phase in which to secure good lung detail. Recognition by radiologists of the importance of minimizing the effects of cardiac activity is reflected in the progressive shortening of exposure. Exposures of ½ second and ⅛ second have given way to those of 1/20 second and 1/40 second. But these are not short enough fully to offset the effects of cardiac movement. At a pulse rate of 80, almost half the cycle is taken up with auricular and ventricular systole.

A blurred cardiac margin is not at all uncommon in 1/20 second exposures made during systole and a thin or shaded cardiac margin, a finer index of movement than blurring, is very common when films are exposed close to the time of systolic discharge. Furthermore, the pulse wave within the pulmonary arterial tree travels about six meters a second. The discharge of blood into the curved, elastic, branching arteries suspended in the elastic lung substance gives the trunks a tendency to straighten like a curved garden hose when water is turned into it. It seems probable also that the pulse sets up a slight but rapid vibration in the peripheral lung.

The effects of systolic discharge in causing blurring are most strikingly seen in the shadows of structures adjacent to the heart. Exposures of 1/20 second made during systolic discharge show a blurred, ill-defined hilum shadow made up of the arterial main stem and the venous and bronchial branches which cross it. Exposures of 1/20

[1]Read before the Thirteenth Annual Meeting of the Radiological Society of North America at New Orleans, Nov. 28–Dec. 2, 1927.

second made during diastole show the arterial main stem shadow and its branches sharply defined, crossed by a few venous and bronchial trunks. When such contrasts in appearance can be secured in films of the same individual on the same day, merely by timing the exposure to occur at different phases of cardiac activity, there is no doubt that the difference in the appearances has not a pathologic but a physiologic basis. The difference is not mainly due to direct thrust of the heart on the lung but to displacement caused by changing pressures in the curved elastic large vessels. It is clear that the distribution of branches in all directions tends to limit displacement, and that displacement will occur in many planes, depending on the direction of curve of the individual branch. But we believe that it has a material effect on detail.

It has been pointed out that auricular and ventricular systole occupies almost half the time of the cycle at pulse rates of 80, and since increase in heart rate is achieved chiefly by shortening diastole, it follows that with healthy children, whose pulse rates at the time of exposure are commonly 90 to 108, the chance of exposure falling during systole is not less than one in two. Consequently there is about an even chance in unsynchronized stereoscopic films that one film of the pair will be made during systole and show in the region of the so-called hilum shadow a greater or less amount of blurring —greater if made during systolic discharge, less if made during auricular movement or presphygmic ventricular contraction. Those who are accustomed to examine each film separately, as well as the pair stereoscopically, must have noticed this disparity in the accuracy with which detail is shown in films intended to be stereoscopic. The clue lies in the size and shape of the heart. In the more blurred film, it can often be seen that the heart appears smaller, and its margin blurred. When such films are viewed stereoscopically the appearances seen in the blurred film may be read into both and a pathologic inference drawn from what is pure artefact. Children suffering from an acute respiratory infection, with elevation of the pulse rate and consequently more frequent systole, are still more likely to show decided blurring of the hilum shadows and trunk markings unless the exposures are synchronized to occur in diastole. During our study of latent tuberculosis carried on at the Henry Phipps Institute (3) during the past four and a half years, we have examined many children before and during and after acute respiratory infections and have never been able to verify, in synchronized films, enlargement or increased density of the hilum region referable to acute infections. It is doubtful whether any other part of the lung field is as much affected by artefacts and extraneous shadows as the hilum. Only a small part of the left hilum shadow is seen. The degree of visibility of that on the right depends (1) on the type of chest, the shadow being more widely separated from the cardiac margin in the long, narrow chest; (2) on the depth of inspiration, for if the diaphragm is high the cardiac border may obscure the hilum shadow. It is idle to lay emphasis on the apparent interval between the heart and the arterial main stem shadow without considering these anatomical factors. A third factor is the condition of the lung anterior and posterior to the hilum. It is important always to remember that a film represents the projection of many planes on to one. Routine oblique exposures will save one from many pitfalls in this regard. The anterior lappet of the upper and middle lobes, and the upper part of the lower lobe are extraordinarily subject to the spread of tuberculous infiltration. Frequently the initial and older deposit in the apex is not clearly seen and the shadows of secondary infiltration into parts anterior or posterior pro-

jected upon and about the hilum shadow are interpreted as a primary lesion spreading from the hilum. This represents one form of the amazing heterogeneity comprised under the term "hilum tuberculosis."

There remain for consideration the actual structures of the hilum. These are the artery lateral, the bronchus central, and the vein medial, with their branches, and the intrapulmonary lymph nodes. So far as they can be recorded on the film the most important of these is the arterial main stem shadow, not for itself but because of its relation to the majority of the intrapulmonary lymph nodes. These nodes, situated at the large bronchial branches, lie lateral to the bronchial main stem, that is, upon the arterial main stem, and are surrounded and crossed by the branches of artery, bronchus, and vein. So situated, they do not cast a distinctive shadow. Their density and their outlines are merged with the similar density and tangled outlines of the trunks which surround them. In order that these lymph nodes may become individually perceptible, they must enlarge so much that their borders project lateral to the lateral margin of the arterial main stem shadow and thus contrast with the air-bearing parenchyma into which they protrude. In a series of about 150 excised inflated lungs, practically all seats of a more or less severe bronchitis, many showing acute bronchopneumonia, we saw no instance in which the lymph nodes did so project, nor any in which the presence of acutely swollen edematous nodes could be inferred by any increase in density of the hilum shadow. Similarly, caseous nodes, unless the seat of calcium infiltration, cast no distinctive shadow in our excised lung series (4). In the living we have seen several instances in which the non-calcified margin of a node containing a large calcium infiltration projected laterally into the air-bearing parenchyma. In such instances there was defined only that sector of the non-calcified inclosing margin of the node which abutted on the parenchyma. In only five instances, all in colored children, have we seen non-calcium-bearing nodes, presumably caseous, projecting as rounded masses lateral to and in one instance also medial to the arterial main-stem shadow. These children were well but all had strongly positive tuberculin reactions. Calcium infiltration of a caseous necrosis, even if discrete and impalpable on section, casts a distinctive shadow, granular, crenated, lamellated. Its presence may be readily detected in synchronized films of the living. The walls of the bronchi tangentially irradiated may cause a similar and misleading appearance in the flat film but will rarely cause difference stereoscopically. The presence of calcium is of importance as an index of severe infection. It is not to be regarded as an indication of obsolescence of the lesion, unless it is dense, sharply defined, and associated with a weak tuberculin reaction. In view of some descriptions of so-called hilum tuberculosis, it is perhaps deserving of note that progression of caseation through the capsule of a lymph node and diffuse infiltration of the areolar tissue of the hilum is quite exceptional, and in our cases was associated with rupture of a node into a vessel or bronchus, and fatal tuberculosis.

Homogeneous smoothly round or oval spots in and about the hilum region are often cast by blood vessels axially radiated. These spots are both more frequent and less confusing in synchronized exposures. For their very number, homogeneous character, and somewhat symmetrical arrangement cast doubt on their having a pathologic significance, and often their origin from a larger trunk can be determined in truly stereoscopic synchronized films. Leaving aside tumors, the structures of the hilum proper are otherwise important only when change in them is part of change affecting also their trunks. For practical purposes, radiologic diagnosis of pulmonary arterial disease, other than congenital anomalies, is rare. The veins, on the other hand, are not

only the first part of the pulmonary circulation to show radiologically perceptible change in certain cardiac lesions, but normally the veins cast the majority of the shadows, as can be seen in synchronized films. Particularly if the right side and shoulder are rotated away from the film and the film slightly over-exposed, the majority of the trunks in the lung field, except the large arterial trunks running directly down to the diaphragm, may be traced back across the arterial main stem and the bronchus into the heart. With synchronized exposures, it is possible to recognize by generalized prominence of venous trunks many cases of cardiac lesion in which the heart size gives no definite evidence of abnormality.

Although it is common to hear the shadows in the pulmonary fields described as bronchi, even in the excised inflated lung the healthy bronchi can only rarely be traced beyond the inner third of the lung field as characteristic double-contoured branching lines. When the bronchial walls are irregularly thickened and dilated as in chronic bronchitis associated with emphysema, a few bronchi can be traced into the middle and rarely into the outer third of the lung field. This is partly due to increased density of the bronchial wall as compared with the parenchyma, and, in the living, partly due to the decreased elasticity of the lung and the consequently decreased movement of the bronchi which accompany the artery. When bronchiectasis is slight and when it is responding to treatment and expectoration is scant, recognition of the lesion is immensely aided by synchronization. Not only is the lung relatively at rest, but the stereoscopic reinforcement of films made in the same phase permits better recording of this elusive stage of the lesion. Furthermore, its differential anatomical diagnosis from the primary or infantile type of diffuse tuberculous infiltration is usually rendered decisive in synchronized films. In contrast to the linear, arborizing disposition of shadows of bronchiectasis, the densities of diffuse tuberculous infiltration form an irregular network which can usually be seen to arise from the pleura and to send interlacing, diminishing, often noded strands towards the hilum. Herein lies the essence of the value of synchronization, that it permits the best obtainable recording of normal structures arborizing from the hilum, renders visible slight differences in general or local prominence of the normal markings and distinguishes them from the irregularly disposed, asymmetrical, infiltrative processes laid down between the normal structures.

Localized prominence of trunk markings in radiograms of the living has engaged much of our attention. This appearance, apart from bronchiectasis, is chiefly seen, if asymmetrical, in areas of infiltration. It is common in areas of tuberculous infiltration whether of apical or childhood type and in areas of non-specific bronchopneumonia. Commonly one finds such X-ray appearances ascribed to thickening of trunks, to peribronchial lymphangitis, or to a peribronchial tuberculosis. The last has not a pathologic counterpart or basis. It is doubtful if an uncomplicated lymphangitis occurs sufficient to add radiologically perceptible density to bronchus or vein or artery. And when one radiates excised inflated lungs one finds that the trunks of supply to infiltrated areas are no more prominent than trunks in comparable areas free from infiltration. Furthermore, pathologic section shows that selective deposition of tubercles about those arteries, bronchi, and veins, large enough to be radiologically recorded, does not occur.

Two explanations arise for the prominence of trunk shadows in infiltrated areas. One, that superposition of spots of infiltration along the line of a trunk draws attention to it and renders it more conspicuous.

jected upon and about the hilum shadow are interpreted as a primary lesion spreading from the hilum. This represents one form of the amazing heterogeneity comprised under the term "hilum tuberculosis."

There remain for consideration the actual structures of the hilum. These are the artery lateral, the bronchus central, and the vein medial, with their branches, and the intrapulmonary lymph nodes. So far as they can be recorded on the film the most important of these is the arterial main stem shadow, not for itself but because of its relation to the majority of the intrapulmonary lymph nodes. These nodes, situated at the large bronchial branches, lie lateral to the bronchial main stem, that is, upon the arterial main stem, and are surrounded and crossed by the branches of artery, bronchus, and vein. So situated, they do not cast a distinctive shadow. Their density and their outlines are merged with the similar density and tangled outlines of the trunks which surround them. In order that these lymph nodes may become individually perceptible, they must enlarge so much that their borders project lateral to the lateral margin of the arterial main stem shadow and thus contrast with the air-bearing parenchyma into which they protrude. In a series of about 150 excised inflated lungs, practically all seats of a more or less severe bronchitis, many showing acute bronchopneumonia, we saw no instance in which the lymph nodes did so project, nor any in which the presence of acutely swollen edematous nodes could be inferred by any increase in density of the hilum shadow. Similarly, caseous nodes, unless the seat of calcium infiltration, cast no distinctive shadow in our excised lung series (4). In the living we have seen several instances in which the non-calcified margin of a node containing a large calcium infiltration projected laterally into the air-bearing parenchyma. In such instances there was defined only that sector of the non-calcified inclosing margin of the node which abutted on the parenchyma. In only five instances, all in colored children, have we seen non-calcium-bearing nodes, presumably caseous, projecting as rounded masses lateral to and in one instance also medial to the arterial main-stem shadow. These children were well but all had strongly positive tuberculin reactions. Calcium infiltration of a caseous necrosis, even if discrete and impalpable on section, casts a distinctive shadow, granular, crenated, lamellated. Its presence may be readily detected in synchronized films of the living. The walls of the bronchi tangentially irradiated may cause a similar and misleading appearance in the flat film but will rarely cause difference stereoscopically. The presence of calcium is of importance as an index of severe infection. It is not to be regarded as an indication of obsolescence of the lesion, unless it is dense, sharply defined. and associated with a weak tuberculin reaction. In view of some descriptions of so-called hilum tuberculosis, it is perhaps deserving of note that progression of caseation through the capsule of a lymph node and diffuse infiltration of the areolar tissue of the hilum is quite exceptional, and in our cases was associated with rupture of a node into a vessel or bronchus, and fatal tuberculosis.

Homogeneous smoothly round or oval spots in and about the hilum region are often cast by blood vessels axially radiated. These spots are both more frequent and less confusing in synchronized exposures. For their very number, homogeneous character, and somewhat symmetrical arrangement cast doubt on their having a pathologic significance, and often their origin from a larger trunk can be determined in truly stereoscopic synchronized films. Leaving aside tumors, the structures of the hilum proper are otherwise important only when change in them is part of change affecting also their trunks. For practical purposes, radiologic diagnosis of pulmonary arterial disease, other than congenital anomalies, is rare. The veins, on the other hand, are not

ography than in an automobile. I think that Coolidge at times has asked questions as to whether we wanted rapid exposures or not, and he has given me the impression at times that roentgenologists did not want speed. Dr. McPhedran will agree with me that there is no limit to the speed, if we can have the other factors satisfactory. I am interested in his method to control the respiratory phase, as I have had some experience in trying to control that feature of the examination. I will just, as a matter of interest, show two slides bearing on that point, and will ask Dr. McPhedran if that might be combined with his method of controlling the heart shadows. This is an historical procedure, but it has stood the test of time. It was borne out just the other day.

This problem is one that has been worked out to determine whether or not the *aviator's heart* dilates as he is deprived of oxygen or goes to a high altitude. As you all will remember, in the case of a famous balloon experiment recently, in which the man went to forty-three thousand feet, the first reports were that he had died of heart failure. However, the final investigation brought out the fact that he had not died of heart failure, but that he *died from lack of oxygen*—because his oxygen gave out or he was unable to use it. That is exactly what this experiment has brought out. Our greatest difficulty was the effect of respiration on the lung shadows and the entire heart silhouette and other structures in the chest. It is impossible to get always a full inspiratory phase and make an exposure at that phase. Even when a clip was placed on the aviator's nose after he had taken a full breath, his diaphragm automatically went up, so that you could not, in a period of thirty or forty seconds, keep that patient in a full inspiratory phase. Automatically there would be a change in the chest itself. Therefore we gave up any idea of taking the chest exactly in a given phase of respiration, but were making very rapid exposures and recording them by a shunt from the current on to a smoked paper that was automatically recording the breathing. The breathing apparatus and tambour, recording inspiration and expiration and the intermediate phases, made a shunt mark hit this when the exposure was made. We had an automatic record of exactly what phase the exposure, which at that time was a twentieth of a second, was made, so that when we hit the peak of inspiration or expiration, we had a record of it and could compare a series of films in that way.

Then the very important problem came up of trying to tabulate these findings. We had a series of exposures, inspiration and expiration, and by combining the heart measurements as devised by Bardeen, for example, in getting the square areas as they actually were, and averaging those that were all nearly in the same phase of respiration, we were able to arrive at certain conclusions, which were, namely, that *the heart does not dilate as the aviator ascends to high altitudes.*

We did one other experiment which is of some interest. We made some exposures just at the beginning of each experiment when the patient was having plenty of oxygen, taking *two exposures on one film.* This gives you the most dramatic representation of the variation in the heart shadows in the same individual between inspiration and expiration. Even the shadows vary, away up at the arch of the aorta, which will expand and contract, and, as Dr. McPhedran has brought out so beautifully, the whole change is transmitted to the finer details of the lungs. I personally want to congratulate Dr. McPhedran on this wonderful advance he has made.

Dr. P. M. Hickey (Ann Arbor, Mich.): I wish to congratulate Dr. McPhedran on the presentation of this very illuminating

paper. The technic demonstrated is a most important step toward the attainment of standardization in X-ray exposures of the chest, and until we do attain standardization in X-rays of the chest we will not be speaking the same language and it will be difficult for different physicians to compare their results. I wish to ask Dr. McPhedran if, in considering the technic of this synchronization, he has had any experience with the use of the electrocardiograph of the amplifier type or with the stethophone? With the stethophone at the University of Michigan, Dr. Wilson has been obtaining some very interesting tracings of the heart sounds and it occurs to me that possibly this same type of amplification could be applied very simply to this problem of synchronization.

Dr. A. U. Desjardins (Rochester, Minn.): Dr. McPhedran's contribution, it seems to me, represents an important step in clearing up many of the problems that have surrounded the radiologic diagnosis of pulmonary disease. When the roentgenologist undertakes to interpret the roentgenologic appearances of different thoracic roentgenograms, one may be called peribronchial infiltration—whatever that may mean; another may be interpreted as representing calcification, and what not. Dr. McPhedran has shown that many of these small round shadows are due, not to calcification, but to the axial projection of blood vessels. The radiographic method which Dr. McPhedran has developed enables him to differentiate clearly between many of the conditions affecting the lungs, and his work will certainly mark a great step in advance in the diagnosis of pulmonary disease.

Dr. R. H. Lafferty (Charlotte, N. C.): I would like to ask the doctor if he has measured the time of exposure of the plate?

Dr. McPhedran (closing): This comment of Dr. LeWald has raised the question of routine use of the Weyl pulse relay. We have used it routinely in the last two and a half years on practically all cases except when it went out of order. I may say that I have more trouble with my commercial timing apparatus than with the pulse relay and its switches. There is one problem we had at the beginning. The X-ray department was in the basement, which was very damp. Philadelphia is notoriously damp in summer, and the pulse relay was so sensitive that if you touched the table, currents resulting from the contact would upset the electrical balance and close the relay. So Mr. Weyl altered it, and now we can run for two months at least on one adjustment. The present model's applicability to routine use depends on how quick one's reflexes are, because exposure at any selected cardiac phase requires closing the foot switch when the light is at the zero position, so that when the next upstroke comes, the circuit is closed by the rise of the light wave, and not in the middle of the wave. This source of error is removable by modifying the circuit.

The electrocardiographic check we have not used on the cardiac cases mentioned, but we have used the clinical check. That is, no case has been missed in the X-ray room which had been diagnosed clinically. We read all our films without knowing anything about the case except the evidence of the films. With the emphasis now being laid on the X-ray in the recognition of cardiac disease, it seems to me that we are bound to come sooner or later to some standard of cardiac film which takes account of the differences in the cardiac diameters due to differences in the depth of respiration and correlates the silhouette with phase of respiration in *terms of vital capacity*, or else do as Dr. LeWald did—take full inspiration and full expiration. That may mean a lot

of work, but if one is going to conserve for a patient the efficiency of his heart, it will be repaid. I am sure we can obtain indication of cardiac damage in some cases by changes in the pulmonary shadows, because we have thus recognized cardiac cases when they have extremely slight physical signs, and one can bring out those physical signs very often on exercise.

Dr. Hickey asks if we use the electrocardiographic method of synchronization in our laboratory. Mr. Weyl has worked with one. There are two problems: one is to get ample excursion of the light or shadow and the other is to get instantaneous exposure on the selected wave or at definite intervals after it. Mr. Weyl tried an apparatus similar to the stethophone, but any noise in the room sets off the apparatus, and if the patient moves the least bit, it is activated.

Dr. Desjardins mentioned the question as to the identity of small spots in the lung-film. When we started doing this work there was uncertainty as to the cause of many spots in and near the hilum. It was necessary to be able to decide which spots were due to disease of the lymph nodes and which to axially radiated vessels. We wanted to find out how often tuberculous nodes occurred in contact as compared with non-contact children; what, if any, symptoms were caused by caseous nodes, and how far they were important as a warning of impending pulmonary infiltration. As a result both of the accurate representation made possible by the pulse relay and of correlation of films of the living with those of excised lungs, we found that many spots which we thought due to nodes were caused by blood vessels. At the start the spots due to vessels bothered us a lot because they would come in one film and not in another.

Answering Dr. Lafferty's question as to length of exposure, I will say that we took this up as part of our problem. The time in the exposures which I have shown was a twentieth or a twenty-fifth of a second at the distance of fifty inches. The routine timing was done by a standard circuit-breaker—it is remarkably accurate. We worked down to a hundred and twentieth of a second in a very few cases, using chiefly the special switch of Mr. Kearsley's design, but we have not enough power to continue that in routine work at present. We were working routinely on a fortieth of a second, using a circuit-breaker, but this broke and I have not had time to get it repaired.

THE MECHANICAL EXPLANATION OF THE BIOLOGICAL ACTION OF RADIATION[1]

By SAMUEL BROWN, M.D., CINCINNATI, OHIO

THE application of X-rays and radium in the treatment of various diseases has resulted in the making of the following observations in regard to their action upon the living tissues, normal or abnormal.

1. The younger the individual the more sensitive are his tissues to radiations.

2. Certain tissues, such as the embryo in the early stages of its development, the lymphoid tissue, and the white blood cells, are highly susceptible to radiation.

3. Within an organ it is the cellular elements that are more readily injured by radiation than the intercellular material.

4. Among tumors, the malignant types are more sensitive to radiation than the benign types.

5. Among the malignant tumors, the one which is the most cellular is the one which yields most readily to radiation.

6. And among the cells, those which are immature, and cells which are in the active stage of division are the most susceptible to radiation.

The above facts are known to all who have had any experience in the treatment of diseases by these agents. Many theories have been advanced in the past to explain the action of radiation upon living tissues, but so far none has been found acceptable.

It has appeared to me that the order in which to evaluate the above facts and to place them in their proper relationship to each other is, first, to reduce them to a common denominator. To do so, it is necessary to find their common characteristics. The one common characteristic possessed by all, which stands out most prominently after a thorough perusal of the facts, is the difference in resistance displayed by the various tissues of the body, normal or abnormal, toward radiations.

What are, then, the underlying factors which determine the degree of resistance? The mechanical engineer, in determining the resistance of a given substance, would proceed to examine its mechanical properties and the forces necessary to overcome them. Cannot the biophysicist proceed with his problem in a like manner and examine the mechanical properties of the living tissues and the forces necessary to overcome them? An attempt will be made in this direction in the following discussion.

The literature concerning the mechanical properties of living tissues is limited. It is, therefore, necessary to resort to the fundamental sciences in order to gather information that sheds light on the subject. It is found that in order to make an analysis of the mechanical properties of the living tissue a study under the following three heads has to be undertaken, namely: (1) Morphological characteristics of living tissues; (2) Chemical composition, and (3) Energetics.

(1) MORPHOLOGICAL CHARACTERISTICS OF LIVING TISSUES

I am here interested in only one phase of the morphological characteristics of tissues, namely, the proportion of cells to intercellular material. All the tissues of the body, normal or abnormal, consist of two elements—cells and intercellular material.

[1]Presented before the Thirteenth Annual Meeting of the Radiological Society of North America, at New Orleans, Nov. 28–Dec. 2, 1927.

The proportion of each of these two elements varies within wide limits. An analysis of the various tissues reveals that the younger, the more active, and the healthier the tissue the greater is its proportion of cells; on the other hand, the older, the less active, and the more diseased a tissue, the greater is its proportion of intercellular material. The significance of the two elements is well known to everybody. The cellular element is the active part. It is the essential element of the tissue and all life manifestations depend upon it. "The intercellular material," according to Adami,[2] "is inert material. The characteristic constituents of matricial matter, such as collagen, elastin, and chondrin, are known for their insolubility in various reagents and the difficulty with which they are dissociated." The proportion of the intercellular element to the cellular element is especially important in the case of newgrowths. "A malignant tumor," says Wells,[3] "differs from a similar benign tumor chiefly in having usually a large proportion of the primary cell constituents and the smaller proportion of the secondary constituents and intercellular substances."

(2) CHEMICAL COMPOSITION OF TISSUES

For my purpose only the chemistry dealing with the water content in tissues will be considered. It is known that water constitutes 70 per cent of the body weight, and yet water itself does not furnish energy to the tissues. Its purpose is to serve as the medium by which free energy in the form of heat is supplied to the tissues. In this respect it is like the coil in the clock, which is the medium by which mechanical energy is transferred to it from some other source and which enables it to maintain the working mechanism of the apparatus. The absence of the coil in the clock or the absence of water in the tissues will produce an absolute cessation of their respective functions. A caution may here be inserted. When speaking of the water content, reference is made to the bound water which represents an integral part of the colloidal system of the tissue and not to the free water found in the tissues of the body under abnormal conditions.

The importance of water in tissues has been amply emphasized by Professor A. Mathews[4] in the following passage: "The younger, the more vigorous, the more alive, the more actively growing, the more impressable cells are, the more watery are they."

An analysis of the tissues as to their water content reveals the following percentages:

Brain (white)	68%
Brain (gray)	84%
Brain (embryo)	91%
Muscles (mammalian)	73%
Muscles (fish)	80%
Electric organs	92%
Liver (human)	76%
Cartilage (hyaline)	67%
Thymus (calf)	77%
Kidney (child)	78%
Suprarenal gland	80%
Dentine[5]	10%
Blood	79%
Corpuscles	64%
Serum[6]	91%
White blood cells[7]	85.5%
Embryo	95%

The above analysis of the normal tissues as regards their water content leads one to recognize one important fact, namely, that the tissues which possess a high water content are those which are composed of a high percentage of the cellular element, while those which are of a low water content have a high percentage of intercellular material. It would, therefore, be appro-

2Principles of Pathology, I, 39.
3Chemical Pathology, page 469.

4Physiological Chemistry, page 13.
5A. Mathews, Physiological Chemistry, page 13.
6Emil Abderhalden, Physiological Chemistry, pp. 554, 555.
7Wooldridge and Halliburton, Reference Handbook of Medical Science.

priate to add to Professor Mathews' quotation, "and the more cellular."

In regard to abnormal tissues, such as newgrowths, I found only one reference as to the water content of tumors. Robin[5] found the water content high and the nitrogen low in carcinoma of the liver in comparison to the normal liver tissue. Without recourse to the analysis of newgrowths as regards their water content, I am justified in inferring that those tumors which are highly cellular in their composition possess, like the normal tissues, a high water content, while the benign growths which are characterized by a high percentage of intercellular material, are, like the normal tissues of a low proportion of cells, of a low water content.

(3) ENERGETICS

One of the properties of water is its specific heat, which is the highest of any liquid substance. According to the researches of Berzelius, Regnault, Dulong, and Petit it was found that more heat is required to raise the temperature of a pound of water, say, 10 degrees, than to increase to the same extent the temperature of an equal weight of almost any other substance. From this it may be inferred that, given two grams of tissue at the same temperature, the one which has a higher percentage of water will contain a greater quantity of heat energy. In view of this inference the heat intensity of an animal, or, as it is usually expressed, the temperature of the body, is not a true indicator of the heat capacities of the different tissues of the body, the latter depending upon the water content of the tissue. By the following method it will be shown how these variations in the heat capacities of tissues can be estimated quantitatively.

One gram of water at normal body temperature (37.5 degrees C.) would possess 37.5 calories, since the calory is the heat required to raise the temperature of one gram of water one degree centigrade. At 37.5 degrees C. it would be equal to 37.5 calories, but this maximum heat capacity could not exist under normal temperatures because the tissues also possess organic material of a low specific heat. The heat capacity of a tissue would, therefore, depend upon the proportion of organic material. The greater the proportion of organic material the lower would be its heat capacity, and *vice versa*. The chief substance of the organic material consists of carbon. Its specific heat is approximately 0.15 that of water at normal body temperature. One gram of carbon at body temperature would be equivalent to 0.15×37.5, which equals 5.6 calories. Given the percentage of water and the percentage of organic matter of any particular tissue, the total caloric value can readily be estimated. For example: The gray matter of the brain contains 84 per cent of water and 16 per cent of organic material.

$$37.5 \times 84/100 - 5.6 \times 16/100 = 32.39 \text{ calories}$$

A caution may here be inserted. When speaking of the heat energy or the caloric value of tissues reference is made to the free heat energy of the tissue and not to the bound energy which the tissue may yield upon oxidation.

Having thus found a method by which the caloric value of tissues can be determined, we may, by applying van't Hoff's Law, realize its full physiological significance. Van't Hoff's Law states that with a rise of temperature of 10 degrees C. the velocity of chemical reactions increases between two and three times. According to this law, two uniform systems will show a difference in the velocity of chemical reactions if the temperature of one is increased, which simply means an increase in the caloric value of that system, with the re-

[5] Cent. Phys. Path. Stoffwechs., 1911, VI, 577.

sulting acceleration of chemical reactions. Applying this law to the living tissues of the body of different caloric values, the rate of chemical reactions would depend upon their respective heat capacities. It may, however, be argued that van't Hoff's Law applies to heat intensities and not to heat capacities. Be that as it may, the fact remains that an acceleration of chemical reactions depends upon heat energy, and it has already been learned that the tissues of the body which are most active are those which possess a high water content and consequently a high heat capacity. We may go one better than van't Hoff. His law fails to explain why the rate of increase is not constant, being greater than twice or thrice at lower temperatures and less at higher temperatures. If the heat capacities are taken in consideration, the inconstancy is readily explained. Let us take four unit systems with heat capacities of 10, 20, 30, 40 calories, respectively. There is twice as much heat energy at 20 as at 10, but only one and a half times between 30 and 20, and still less between 40 and 30, which is one and one-third. The proportion between two respective unit systems grows less as the total heat capacities are increased. Hence the explanation for the inconstancy of chemical acceleration as the heat intensities are advanced. It is thus evident that chemical acceleration is chiefly a function of the heat capacities and not of the heat intensities alone.

The mechanical properties of tissues, therefore, depend upon the heat capacities of each respective tissue, and this, in turn, depends upon the water content of the tissues, and the proportion of water in the tissues depends upon the proportion of cells to intercellular material. The heat capacity thus determines the chemical potential of the tissue. The higher the chemical potential of a tissue the less is its stability, and the less stable the less resistance does it offer toward any force. The force that is used is immaterial, be it heat, light, ultra-violet light, X-ray, or radium. The physical effect will depend upon the form of energy used, but the chemical effect, if such takes place, is the function of the tissue itself. This may be expressed to advantage by the following two laws:

1. The physical change of a substance is the function of the form of energy absorbed.
2. The chemical change of a substance, if such takes place, is the function of the substance itself.

I will not enter into a discussion of the validity of these laws. A little reflection on the part of the reader will be sufficient for him to see the truth which these laws aim to express. With this in mind, one does not have to search for an explanation as to how the radiations act, but rather as to how the tissues react, and this has been shown above to depend upon the mechanical properties of the tissues.

CONCLUSION

It is a universal fact that the resistance of a body depends upon its heat capacity. The more heat a body possesses the less its resistance. The living tissue, normal or abnormal, is no exception to this rule. It has been shown that the heat capacities of tissues vary, and this depends upon the water content, while this in turn depends upon the proportion of cells to intercellular material. By a simple method it has been shown that the heat capacities can be estimated and thus their resistance established. It now becomes evident why certain tissues, normal or abnormal, are more susceptible to radiation than others. It is the tissue which is highly cellular, and, therefore, of a high heat capacity, that yields so readily to radiation of a certain quantity and not to the quality of radiation.

BONE CHANGES IN LEPROSY[1]

By RALPH HOPKINS, M.D., New Orleans

I DEEPLY appreciate this privilege, though I fear it may be considered presumptuous for a dermatologist to discuss bone changes before this Society. I may say, however, that the purpose of this presentation is to obtain your assistance in interpreting what is, to us, a puzzling phenomenon in bone pathology. It may facilitate your interpretation if I describe some of the clinical manifestations preceding or concomitant with the bone changes.

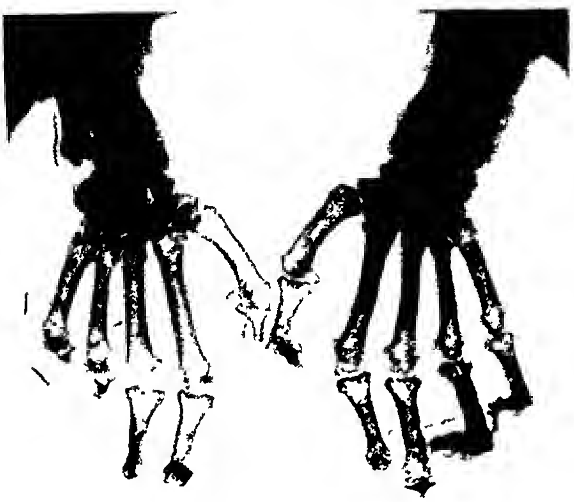

Fig 1. Illustrating bone changes in "claw hand."

Fig. 2. Illustrating bone changes due to absorption without amputation.

Leprosy affects primarily the skin or nerves. The skin type is totally different in its symptomatology from the nerve type, but combination of the two types in the same individual is frequent. The type is dependent on the habitat of the *Bacillus hansenii,* which is found either in the skin or nerves, or both. Bone changes are usually found in both types of the disease and the most marked and most rapidly advancing changes occur in cases of the mixed type, presenting both skin and nerve lesions.

The most notable changes occur in the phalanges of both extremities and in the nasal septum, while the bones of the trunk and the long bones of the limbs remain unaffected. Like other symptoms of leprosy, there is often a curious limitation to the most peripheral parts; cases even of long duration may show no bone changes except in the most distal phalanges. Disintegration occurs in the epiphyses as well as diaphyses.

The time factor involved in the loss of bone is widely variable but most often the process is very slow. Ten, twenty, or thirty years may elapse while the digits are gradually shortening on account of a slow bone absorption. When suppuration with secondary infection occurs, however, the course is much more rapid.

[1]Read before the Radiological Society of North America, at the Thirteenth Annual Meeting, at New Orleans, Nov. 29, 1927.

Fig. 3. Bone changes of greater and less extent in the same patient.

Fig. 4. Late bone changes, with considerable deformity.

In the nerve type, the skin of the hands and feet remains apparently normal, symptoms being limited at first to effects of interference with nerve function and later to loss of bone. The ulnars are usually the first to be involved, and the disturbance commences at the peripheral distribution and slowly progresses centrically. The tip of the little finger is usually involved first, and loss of function of the sensory fibers precedes impairment of the motor. Of the sensory fibers those mediating pain are the first involved. Epicritic sensations of temperature and touch are lost next, and finally even protopathic sensibility is abolished. Following loss of sensation, symptoms of motor paralysis occur. There are muscular atrophy, impairment of muscular function, and contractions causing considerable deformity. The claw hand of leprosy is a result of atrophy and contracture of the flexing mechanism, most marked when loss of bone is inconsiderable.

In the skin type of leprosy, the bacillus shows a marked preference for the exposed surfaces, and in consequence the hands in advanced cases are almost always involved. Evidence of the presence of *Bacillus hansenii* is found in nodules or in diffuse infiltrated areas, most often on the dorsal surface. The hands are greatly swollen, of a brown or violaceous color, and the indurated areas may be hard and extend in depth to the periosteum, rendering the skin and subjacent tissue of the dorsal surfaces immovable over the carpal bones. Anesthesia may be found in types of this kind, but differs from that of the nerve type in that it is limited to the skin areas involved rather than to a nerve distribution.

In the mixed type the symptoms are a combination of those found in the nerve and skin types and the bone changes are more rapidly progressive.

Actual loss of bone causing the mutilation of hands and feet characteristic of leprosy occurs in several ways. There may be an absorption without any external evidence of inflammation or suppuration. The bone loss is followed by retraction of the soft tissues, remnants of the nails often remaining

even when the digit has completely disappeared.

In other cases the condition which has been called ainhum occurs. A narrow constricting band of fibrous tissue encircling the finger or toe appears, which, gradually growing tighter, indents the digit as would the wearing of a ring that was too small. The indentation grows deeper until but a cord or thread remains as a connecting link. This finally breaks.

More commonly, necrosis of bone is associated with suppuration, the formation of sinuses, and secondary infection. Gangrene may occur, necessitating surgical amputation. In neglected cases the amputation is spontaneous. Associated with the sinus leading to necrotic bone is the perforating ulcer, which occurs most often on the ball of the foot. These ulcers persist almost indefinitely if the dead bone is not absorbed or spontaneously discharged or surgically removed.

The slides by which this paper is illustrated were made by Dr. Oswald E. Denney, Officer in Charge of Marine Hospital No. 66, from films made by the technician at that institution, Sister Martha Lawler.

DISCUSSION

Dr. Paul A. McIlhenny (New Orleans): It is rather absurd that an orthopedic surgeon should attempt to tell a group of radiologists what they should do or not do. I have been so fortunate as to examine Dr. Hopkins' plates on the bone changes which we see only in leprosy. The question is, are these bone changes typical of leprosy? I have given this question considerable study and, after some four years of observation, with the aid of many X-ray plates of bone changes, I am unable to make a differential diagnosis of a leper's hand as distinct from other forms of bony changes. It is true that we have characteristic changes attended with anesthesia in certain types of leprosy, but that these changes are typical of leprosy I am not at this time willing to assert. I hope some of you who have had a greater experience may help us out in this problem.

One peculiarity about leprosy is that we do not find arthritis. I have never seen an X-ray plate showing arthritis in leprosy.

Neither do you find osteomyelitis. It seems that osteomyelitis does not accompany leprosy. While we may find osteitis in the carpals, in the metacarpals, in the tarsals and the metatarsals, we do not find osteomyelitis.

Rarefaction takes place, as Dr. Hopkins so thoroughly described, in the nerve type especially. Then we have atrophy and hypertrophy in the nodular type, with absorption, inflammation, and suppuration.

In the combined type you may find a combination of all of the symptoms of the two separate types. The absorption grows gradually to such extent that eventually you will have only a finger nail at the base of the carpal or metacarpal, or tarsal or metatarsal. You may have a destructive process involving the base of the metacarpal and you may have an osteitis which may go on to such extent that a pseudo-arthrosis will be produced.

Now all of these changes, as illustrated, do occur in leprosy, in the hands and feet, and they may be characteristic of the hands and feet, but do you not find the same or similar changes in Raynaud's disease, or other trophic disturbances? I have an X-ray film of a congenital deformity of a patient's left hand. We had at the clinic a patient that presented practically the same deformity in his hand and the same X-ray film as the congenital deformity. The congenital deformity was a case with no anesthesia, with no nodular or nerve destruction, and no evidence of leprosy, but it presented

practically the same picture as one with the nerve and nodular type of leprosy. In consequence I am frank in stating that I cannot diagnose a leper's hand from an X-ray film, but I hope that you may throw some light on this question for us..

On the Cure of Fistulæ of the Ureter by Termination of the Kidney Function by Means of Roentgen Rays. Paul Klein. Strahlentherapie, 1928, XXVIII, 482.

Following radical operation (Wertheim) for carcinoma of the uterus, quite often fistulæ of the ureter develop. Numerous surgical methods for removal of this condition have been suggested but with little success. In many cases, nephrectomy is the only choice left. Although this operation can not be regarded as very dangerous, the author has made an attempt to substitute roentgen rays for the surgical knife. He irradiated the kidney of a diseased ureter with a dose heavy enough to cause fibrous changes in the kidney and stop its function permanently. Technic· 200 K.V., 30 cm., F.S.D., 6×8 or 12×16 cm. abdominal and dorsal field, 0.5 Zn. plus 1.0 Al., 90 per cent S.U.D. effective in the kidney, one to three series. So far, four cases have been successfully treated; two other cases have not shown any results. Before the treatment, the function of the other kidney must be tested and should be intact. The question of dosage can not be regarded as settled; future experience may modify it. It would be interesting to examine microscopically a kidney treated by roentgen rays some time after its function has been stopped.

E. A. Pohle, M.D.

SURFACE APPLICATIONS OF RADIUM[1]

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IT is perhaps too little appreciated that the results from radium treatment depend largely upon the manner in which it is applied. While there is nothing so valuable as experience in deciding the method of procedure in each individual case, still there are general principles which should be adhered to. In planning the treatment of a case by surface applications of radium, the following questions must be considered:

1. How much radium shall be used?
2. How shall it be distributed?
3. How shall it be filtered?
4. How far away from the surface shall it be placed?
5. How long shall it remain in place?
6. When shall the treatment be repeated?

Quantity.—With the understanding that this paper deals with radium element only and not radon, with which I have no personal experience, the first question is probably the least important of all and will be considered superfluous by the average user of radium, who will use all he has, or at least all he has available at the moment. If we except radium plaques, probably 10 mg. of the element is the smallest amount which is practical to use as a unit, and 25 mg. for this purpose is usually better practice. With this in mind, one may either divide his radium into sufficient units to cover the involved area at one sitting, or, if he has not sufficient radium for this purpose, will treat as large an area as the available radium will cover and at the end of a prescribed time move it to a similar area, repeating this process until the desired surface has been covered. If malignant disease is being treated, it is my belief that a full dose should be administered as quickly as the radium supply will admit. Other things being equal, it is probably true that the effect of a treatment is in direct proportion to the number of milligram hours used. That is to say, the effect of 25 milligrams applied for four hours is the same as 100 milligrams applied for one hour. It has been claimed by some authors, notably Regaud, that very small amounts of radium left in position for several days have a better effect than the customary practice of a proportionately larger quantity left for a matter of hours. It is thought that this technic is apt to expose a larger percentage of cancer cells when they are in a state of mitosis and consequently more vulnerable. Regaud's work applies particularly to the embedding of very small radium needles, but, if his conclusions are correct, the same principle should be equally applicable to surface applications. I have no personal experience to prove or disprove this theory but it seems a matter worthy of investigation.

Distribution.—The manner of distribution of the radium should be such that all parts of the surface treated receive the same dose. The ideal condition, of course, would be that all parts of the involved area, surface and depth included, should receive the same dose, but this is not even theoretically possible by surface application. However, it is possible to apply a uniform dosage to the entire surface area treated. To accomplish this, equal units of radium should be so placed that the distance between units in both directions is one and one-half times the distance from the radium to the surface treated. In using tubes or hollow needles of radium inside brass capsules as a filter, it must be remembered that the radium does not extend to the ends of these containers.

[1]Read before the Radiological Society of North America, at the Thirteenth Annual Meeting, at New Orleans, Nov. 28–Dec. 2, 1927.

and allowance must be made for this in measuring the distance between units in that dimension. In placing units at this distance apart (*i.e.*, one and one-half times the distance to the skin surface), the skin directly beneath one unit receives approximately 25 per cent of a dose from each unit which is placed next to it in each direction. Therefore, the effect of a unit entirely surrounded by similar units would be 100 per cent greater than it would be if only one area were treated by one unit. To illustrate, if the erythema dose of a certain unit of radium with a specified technic is 15 hours and this dosage is given to a skin area surrounded by four other similarly treated areas, the central area will receive the equivalent of 30 hours dosage. A moment's reflection also shows that where a large area is treated by dividing it into numerous smaller areas, the areas around the edge receive a smaller dosage than those which are entirely surrounded by other areas. In a malignant lesion, the most vital part of the growth is at the edge and the edges should receive more and not less treatment than the center. Therefore, this should always be kept in mind when placing the radium and a generous margin should be included in the area to be treated.

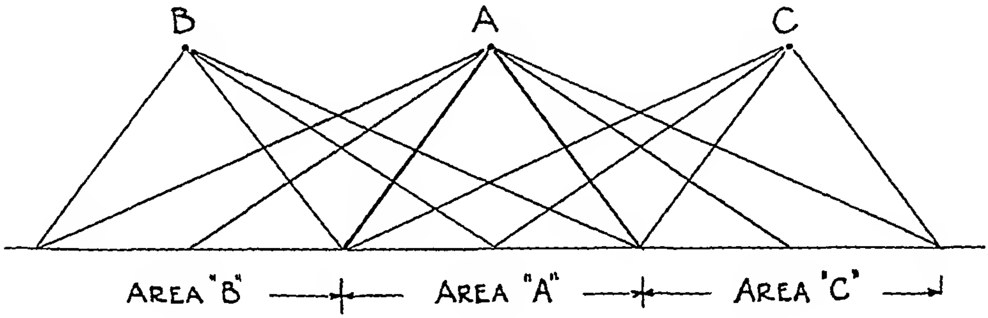

Fig. 1. Illustrating the overlapping effect when contiguous areas are treated.

Filtration.—As time goes on, I find less and less use for any other filter than one millimeter of brass, properly covered to absorb the secondary radiation from the metal itself. Theoretically, the filter should be chosen to correspond to the character and thickness of the lesion, but in practice I find that I obtain better results, even in surface lesions, with brass filters than with aluminum or other easily penetrable filters. This may possibly be a question of dosage, as it is customary to leave aluminum-filtered radium in place a much shorter time than in cases where brass filters are used, on account of the more violent surface reaction in the lightly filtered radiation. However, the shorter application would appear to be the only advantage in the aluminum filtration. If it is necessary to leave aluminum-filtered radium in place the same length of time as brass-filtered radium, the latter is preferable because there is less escharotic effect. It would seem that whatever beneficial effect is possible from the use of radium can be obtained by the use of the harder beta rays and the gamma rays—possibly from the latter alone. The gold, lead, brass or other filter of heavy metal should always be covered with an additional filter which has the capacity to absorb the secondary rays emitted by the metal and which gives off no secondary rays of its own. The materials usually used for this purpose are soft pure rubber, hard rubber, or aluminum. If this secondary filter is not used, a violent escharotic effect may follow, which serves no useful purpose and is painful and undesirable.

Distance.—The action of radium is governed by the inverse square law in the same sense as are X-rays, and as the distance at which radium is customarily used is much less the necessity of accurate measurement

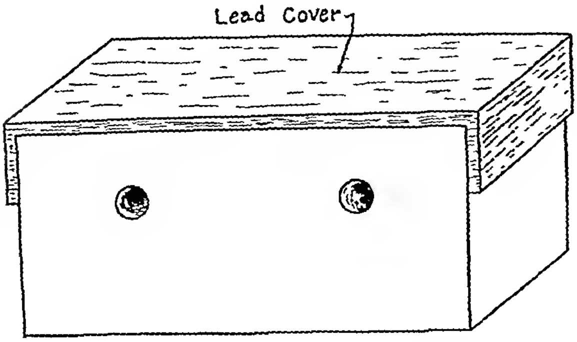

Fig. 2. Convenient pith wood applicator. The distance between holes is one and one-half times the distance to the bottom of the block.

is proportionately greater. If we exclude the two or three radium packs each containing more than a gram of radium which are in existence in this country, the average owner of radium does not have available enough radium to allow him to apply it at a much greater distance than an inch, or the length of time needed to give a treatment would be prohibitive. Since the distances we are dealing with are usually fractions of an inch, slight errors in measuring this distance will result in a decided error of dosage. Likewise, the use of applicators which make uncertain contact or are easily misplaced or are compressible may result in errors of distance. The ideal applicator holds the radium accurately at a known distance for the entire period of the application. For treatment over skin surfaces which are not too irregular in contour and where it is desirable to use the radium one-half inch or more from the surface, I have found pith wood to make an ideal applicator. Its specific gravity is so low as to offer almost no resistance to the rays and it is rigid and therefore maintains the radium at a fixed distance. A convenient applicator is made by boring a hole in the end of a piece of this wood at the desired distance from the surface and inserting the radium capsule into this hole. Applicators may be made with as many of these holes as one desires, spaced the proper distance apart, that is, one and one-half times the distance to the surface. The back of this applicator can be covered with lead to protect surrounding parts from the radiation. Where it is desired to treat at a distance of one-fourth inch or less, a handy method is to place the brass capsule inside a piece of rubber tubing having walls of one, two, or three millimeters in thickness. The area to be treated may be covered by placing these capsules in contact with each other. The spacing will then be in the relation of two to one instead of one and one-half to one, which is scientifically incorrect but in practice seems to be all right, probably for the reason that most lesions treated by this method are surface malignancies and are usually over-dosed by a generous margin.

In treating birthmarks, where it is important to have a uniform radiation over the whole area, the proper relation between skin distance and spacing can be maintained by adding a millimeter or two of rubber sheeting between the radium and the skin. For treating at distances between one-fourth and one-half inch it is convenient to place the radium covered by rubber tubing inside a larger piece of tubing. For surface areas which are very irregular in contour, an applicator may be made of dental modelling compound and the radium fastened to the outside of this. However, there are very few areas which can not be treated either with 25 mg. units in rubber tubing of various thicknesses or with the wood applicators.

It sometimes requires considerable ingenuity to hold the radium at the desired distance or in accurate contact for the entire length of the treatment. This is par-

TABLE I

LESIONS TREATED BY SURFACE APPLICATIONS

Lesion	Quantity	Filter	Distance	Time	Interval
Carcinoma of mouth	25 mg. units to cover lesion	1 mm. brass 2 mm. rubber	5 mm.	14 hours	6 weeks
Tonsils, external application	50 mg.	1 mm. brass and wood	1 inch	13 hours	3 months; repeat once
Metastatic malignant nodules	25 mg. units to cover lesion	1 mm. brass and wood	¾ inch	14 hours one area	6 weeks
Exophthalmic goiter	Two 25 mg. units over each lobe	1 mm. brass and wood	¾ inch	8 hours	6 weeks
Thymus	Four 25 mg. units	1 mm. brass and wood	¾ inch	10 hours	8 weeks if necessary
Glands in Hodgkin's disease	25 mg. units to cover lesion	1 mm. brass and wood	¾ inch	12 hours	6 weeks
Birthmarks	25 mg. units to cover lesion	1 mm. brass 2 mm. rubber	5 mm.	1½ hours	8 weeks
Spleen in leukemia	Two 25 mg. units over each area	1 mm. brass and wood	¾ inch	6 hours each area	8 weeks
Carcinoma of prostate, urethral; carcinoma of prostate, rectal	50 mg. 50 mg.	1 mm. brass 1 mm. aluminum; 1 mm. brass 2 mm. rubber	4 mm. 6 mm.	2 hours; 3 hours each area	6 weeks 6 weeks
Carcinoma of rectum	50 mg.	1 mm. brass 2 mm. hard rubber	6 mm.	10 hours	6 weeks
Carcinoma of penis	50 mg.	1 mm. brass 2 mm. rubber	5 mm.	6 hours	6 weeks
Carcinoma of cervix uteri; carcinoma of fundus	25 mg. units to cover lesion; 50 mg.	1 mm. brass 2 mm. rubber; 1 mm. brass 1 mm. hard rubber or 1 mm. aluminum	5 mm. 4 mm.	48 hours; 48 hours	8 weeks ....

ticularly true when the radium is applied in the body cavities. For treatment in the mouth, the radium, covered by rubber tubing, may be fastened to the end of a strip of sheet lead and this inserted into the mouth and so bent that the radium comes in accurate contact with the lesion. The end of the strip of lead which projects from the mouth is bent around against the cheek and fastened there by adhesive and bandages. This method of application has been previously described in detail by the author (1). It has proven so very satisfactory that I mention it again at this time.

For treatment of esophageal lesions, I use a gold filter which is thinner than brass and therefore smaller in diameter and which is coated with hard rubber. A flexible cable screws into the end of this filter. It holds 50 mg. of radium in needles. It can be placed in position through an esophagoscope and the cable is sufficiently rigid to hold it in position.

For treatment of the prostate intra-

urethrally, I have an aluminum sound with the curve of an ordinary urethral sound and a hollow tip in which 50 mg. of radium can be placed.

For treating the prostate through the rectum the soft rubber bougie devised by Dr. W. H. Cameron has been very satisfactory.

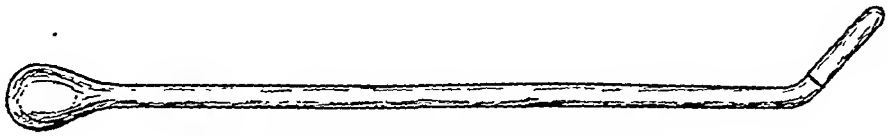

Fig. 3. Aluminum urethral applicator.

For carcinoma of the cervix of the uterus, 25 mg. units covered by rubber tubing and placed side by side to cover the lesion will be found satisfactory in most cases. Where the lesion involves the outside of the cervix and also extends up into the cervical canal, I use a special applicator which consists of two pieces. These are made of aluminum and do not need to be covered. The piece that goes into the cervical canal is shaped like the ordinary uterine sound: the upper end is solid and occupies the body of the uterus when it is in position; the lower end is hollow and holds a 25 mg. brass capsule—this part of the applicator is in the cervical canal and the end projects from the external os. The second part of the apparatus is flat and contains two cavities each of which holds a 25 mg. brass capsule. A round hole in the middle of this piece allows it to be slipped over the projecting end of the applicator in the cervix. Packing placed against the flat piece holds both parts of the apparatus in position.

In treating carcinoma of the rectum various applicators may be fonnd necessary, depending upon the involvement. They may

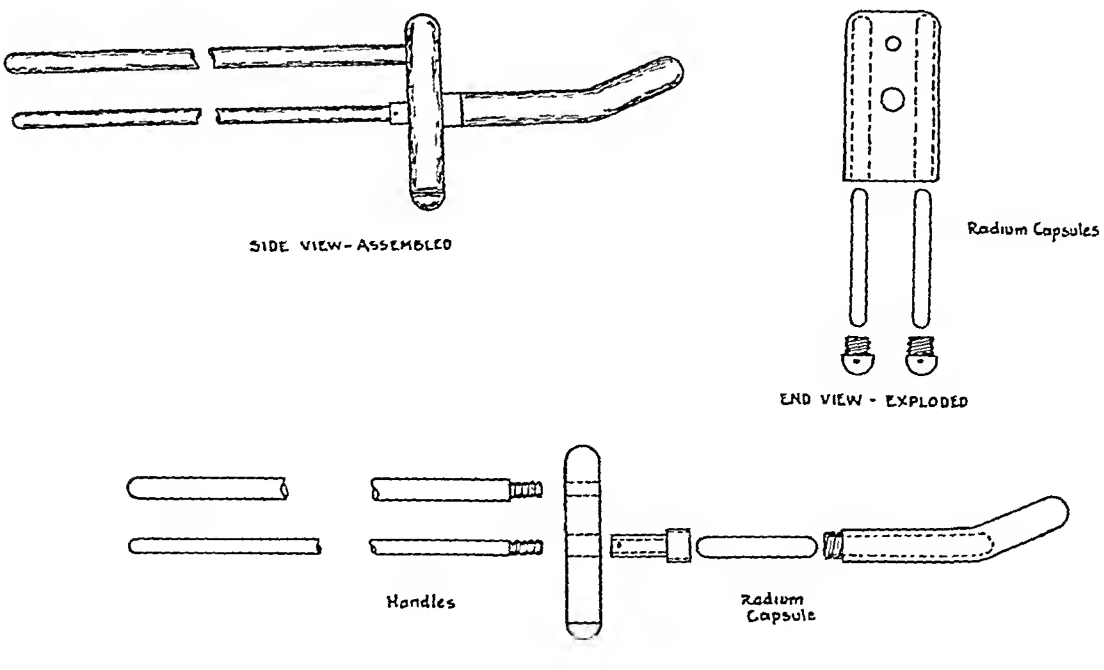

Fig. 4. Aluminum uterine applicator.

consist of either a hard rubber or an aluminum shell in which the brass capsules are placed, or sometimes the capsules may be placed inside a section of soft rubber tubing. Whichever of these is used, I believe a flexible wire should be fastened to it, extending through the anus so that it can be fastened outside and thus the radium can be held in position.

Radium should never be applied in such a manner that the exact distance from the surface is unknown, such as wrapping it up in a piece of gauze, for instance. Gauze pads make poor applicators because they are compressible and the distance from the radium to the surface may be altered by the pressure from the adhesive or bandages which are used to hold them on.

Length of application.—This factor is dependent upon the amount of radium used, the filtration, and the distance from the surface. It will also vary depending upon the effect desired. In treating malignant ulcerations I always use a dose which produces tissue necrosis. On the other hand, birthmarks are usually given a little less than an erythema dose. While one must be allowed a wide latitude in applying a dosage to suit the requirement of individual cases, the doses which I usually employ in the average case are as shown in Table I.

Repetition of treatment.—In treating primary surface malignancies, I always attempt to produce complete destruction of the lesion at one application. This is not always possible owing to the distribution of the lesion, uncertain contact or other causes. Any areas which show evidence of vitality at the end of six weeks should receive another treatment. However, the effort should be made to destroy the lesion at one sitting rather than to give one-third of this dose once a week or some similar plan of divided dosage. In treating lesions situated beneath healthy skin a single destructive dose is seldom if ever practical. If the lesion is malignant, the common practice is to give a mild erythema dose and repeat this every six weeks until the desired effect is produced. It is probably not safe to give more than four such treatments. As a matter of fact, I doubt if there is ever any favorable response to treatment after this amount of radiation has been applied. If it is desired to use the saturation method of treatment, Pfahler's chart devised for deep therapy X-ray will be found applicable to radium treatment. Where it is important that secondary skin changes shall not occur, as in birthmark cases or keloids, the application should always be less than an erythema dose and the interval between treatments about eight weeks.

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Idem: The Treatment of Intra-oral Carcinoma by Contact Application of Radium. Am. Jour. Roentgenol. and Rad. Ther., March, 1926, XV.

DISCUSSION

Dr. Albert Soiland (Los Angeles, Calif.): This symposium on the technical application of radium covers the important everyday problems which confront all of us who are doing radium work. Dr. Grier's paper is timely; he has gone over the usual routine and brought out some excellent points. I should like to stress the part of his paper which deals with the local surface applicators. I think this is the most abused form of radium that has ever been manufactured for the American radiologist. If the surface plaques were directed only to conditions which are distinctly superficial affairs, and used intelligently, no comments would be necessary. We see cancer patients, however, who go to the dermatologist, and nearly every dermatologist in the United States has at least one radium plaque which is frequently sorely abused. We have seen many instances where a sur-

face applicator has irritated an epithelioma to the point of deep necrosis, with the result that radium therapy is discredited, and finally, if the patient who has been treated in this manner comes to the radiologist, he may be too far advanced to receive help from further radiation therapy.

DR. SANFORD WITHERS (Denver, Colo.): Dr. Grier has intimated that he makes repeated surface applications of a full erythema dose, at intervals of six weeks. We have attempted to do this on several patients, but found that the third or fourth application usually resulted in a painful slough which was healed with difficulty. We should like to have Dr. Grier tell us how he avoids this complication.

DR. GRIER (closing): There should be no misunderstanding about the scope of the paper I have read. I was not advocating in that paper any surface application to replace implantations where needed. The object of the paper was simply to describe a technic of surface applications when they were chosen, not as a substitute for implantations; that is, I was not trying to imply in any way that surface application alone should be the only method of treatment.

What I said was that more than four such treatments should not be given. As a matter of fact, I never did use four myself. From a medico-legal standpoint, it might have been better if I had not said anything about how many treatments, but this subject was too important. I doubt whether anything is ever gained by giving the treatment more than once. but to give a liberal margin I said four times.

ACTUAL TECHNIC OF EXAMINATION OF THE SPINAL CAVITIES WITH LIPIODOL[1]

By JACQUES FORESTIER, M.D., F.A.C.R., AIX-LES-BAINS, FRANCE

FIVE years ago, with J. A. Sicard, we showed that lipiodol could be injected into the subarachnoid cavity, and be used as an opaque material, visible to X-ray, in order to test the patency or the blocking of this cavity (1). The lipiodol drops remain movable for some time in the cerebrospinal fluid and can be directed from one extremity of the spine to the other by the force of gravity. This method has proved to be diagnostic for the early and accurate localization of compressions of the spinal cord.

Since lipiodol injected into the cerebrospinal fluid is affected by gravity, we tried at first to inject it above the supposed zone of compression, and to take films of the spine, the patient being in an erect posture. After a few attempts we adopted, with J. A. Sicard and L. Laplane, the injection into the cisterna magna after Ayer's puncture. By this method it has been made possible to demonstrate the upper limit of the compression directly with regard to the vertebræ. This is the technic we recommended two years ago in the United States (2). On the whole, it is an excellent technic to use in many conditions, and in the hands of many European and American neurologists and in our own it has given quite satisfactory results.

But some few objections may be offered to it. (1) The cisternal injection is difficult and can be dangerous, though, we must say, in our own experience we have not seen any accident. (2) The transit of the oily globule after this injection, which must be made with the patient in sitting or half sitting posture, is very rapid, and practically before the patient can be examined radiologically the oily globule has already reached the obstacle or the lower extremity of the subarachnoid cavity. It is quite possible that, at the beginning of the evolution of spinal cord compressions, when the block is only partial, the latter may be overlooked. Such has been the experience of Babinski (3), Guillain, and a few others when a normal transit of lipiodol was reported in patients suspected of spinal cord compressions. A few months later the spinal block was revealed by a second examination with lipiodol.

In 1924, with Laplane, we attempted to examine fluoroscopically the transit of lipiodol after intracisternal injection, but the examination, which was not easy with the usual X-ray apparatus, did not give any better results than those obtained with our usual technic. During the same year we tried to perform the examination of the spinal subarachnoid space after lumbar injection of lipiodol, the patient being put in the Trendelenburg or the knee-chest position. But these attempts did not give us any practical results on account of the fact that we had not been able, with the use of an ordinary X-ray table, to secure a regular transit of the oily globule over the curvatures of the spine.

Sicard and Binet, in 1924 (4), attempted to examine the spinal cavity by lumbar injection of light (or ascending) lipiodol. This technic, which has yielded some results, causes more difficult interpretation and we do not use it any longer except in those cases wherein, having demonstrated the upper pole of the compression with or-

[1] Read before the Radiological Society of North America, at the Thirteenth Annual Meeting, at New Orleans, Dec. 1, 1927.

dinary lipiodol, injected intracisternally, we wish to demarcate the lower pole.

ACTUAL TECHNIC

Since we have used a fluoroscopic tilting table on which the patient can be firmly tied and then put in head-down position at an angle of 60° or 70° with the horizontal, we have been able to perform the lumbar injection of lipiodol and examine fluoroscopically its transit with much less fear of misinterpretation.

The tilting table used by us, and built by Raulot-Lapointe, Paris, can be adjusted progressively to any inclination, from horizontal to vertical, and is adapted for fluoroscopy as well as radiography in any position. The patient is secured to the table by a series of straps fixed over the shoulders and across the chest, and can be examined in either the prone or the supine position or at

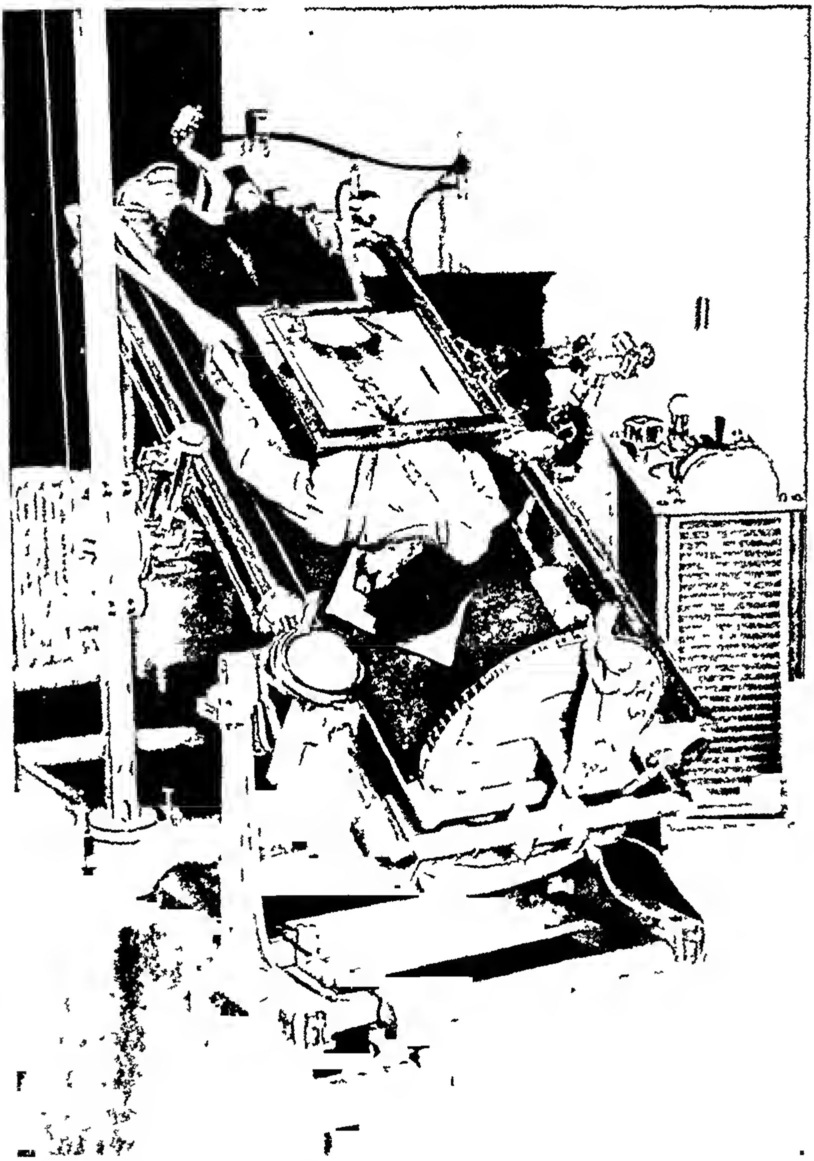


Fig 1 Radiologic tilting table for the subarachnoid lipiodol test after lumbar injection

any degree of obliquity, owing to the revolving of the bed of the table on its long axis (Fig. 1). Any table offering similar features may be used for the following technic. Conversely, any lipiodol test of the subarachnoid space after lumbar injection made without such a tilting table, is subject to errors in interpretation which may be detrimental to patients.

OPERATIVE METHOD

We proceed in the following manner: After the usual clinical and X-ray examination the patient is placed on the radiologic table, set in the horizontal position. The lumbar puncture is done at the usual level, the patient lying on one side. A few cubic centimeters of cerebrospinal fluid are withdrawn for immediate dosage of the total protein content with the Sicard and Cantaloube tube. A little experience in the test allows of a quick approximate appreciation of the protein content of the fluid. The manometric tests of the subarachnoid space (Queckenstedt) are likewise performed.

When these examinations give either the certainty or the suspicion of a subarachnoid block 1 c.c. of lipiodol is readily injected, with the usual precautions. After the needle has been removed the patient is placed in the prone position on the table and tied with broad canvas straps, his head lying on a pillow. In this position he may be erected in a head-down position, up to an angle of 70° without any apprehension of danger. The first step, the examination of the lipiodol globule, is done while the table is still horizontal. When the form and position of the lipiodol in the lumbosacral cul-de-sac have been noted, the table is quickly raised by means of a reel, which may be moved electrically, and, within two or three minutes, placed at an angle bearable by the patient. During all the time the lipiodol globule is moving, its course may be watched fluoroscopically and at any moment an X-ray film may be substituted for the screen, if any interesting phase appears. The radiogram is taken in the very position wherein the patient has been examined fluoroscopically. If the lipiodol globule has moved to the cervical extremity of the spinal canal, the transit in the opposite direction may be watched too. For this second part of the examination, the table is brought back to the horizontal position, and the patient, remaining in the prone posture, is shifted across the table, so that his head takes the place of his feet and *vice versa*. When the table is again raised, the lipiodol may be watched in the same manner, sliding from the occipital region down to the lumbar spine. This part of the examination is generally more difficult on account of the high position of the segment to be examined, and the rapidity of the fall of the oil. In case of difficult interpretation, the examination may be repeated several times, either in the prone or the supine position, or even in the oblique position, when the lateral fields of the subarachnoid cavity are to be more carefully examined.

One may be apprehensive, perhaps, how these different maneuvers will be borne by the patient; it is surprising how easily the head-down position at an angle of 60° to 70° is tolerated by the patient, and we have never had any accident while employing this technic.

RESULTS OF THIS METHOD

1. *Normal Subarachnoid Space.*—If the patient is in the prone position on the horizontal table, the lipiodol globule is seen, in the shape of a radish—more or less elongated—at the level of the fifth or fourth lumbar vertebra. Its mobility may be tested by turning the patient slightly on one side. Upon the patient's coughing, the oily ball lengthens; if the jugular veins are compressed with the fingers (Queckenstedt's

Fig 2 Complete spinal block by an intradural tumor Lumbar injection of 1 c c of lipiodol Examination of the transit in the head-down position at an angle of 60 degrees Arrow indicates direction of gravity.

test), the ball gathers itself at the bottom of the cul-de-sac. As soon as the table has been put in an inclined position, with the head of the patient down, the lipiodol globule begins its progress toward the cephalic extremity; it becomes elongated and passes slowly through the lumbar and lower dorsal segments. The picture remains the same in the middle dorsal segment but is not seen so well on account of the shadows of the diaphragm and of the heart. When the globule reaches the level of the fourth or second thoracic vertebra, its motion becomes slower for a little distance on account of the anatomical narrowing of the spinal canal at this level. Then, the cavity becoming abruptly wider, the long splotch of lipiodol is very promptly fragmented into small drops which escape from its lower extremity and fall by themselves along the cervical segment, gathering themselves again behind the occipital bone in the cisterna magna

If the patient is kept in the inclined position for a few minutes, it may happen that a small part of the lipiodol will be retained locally in the subarachnoid space, and will not fall back immediately when the patient is again put in the erect position. This does not give rise to any accident, and, remarkably, the patient does not feel the least sensation from the movement of the oil along the nerve roots. If the transit of lipiodol is then to be examined while the globule falls in the opposite direction, *viz.*, from the cervical to the lumbar segment, it is essential that the table should be erected very gradually. If the maneuver is performed too quickly, the fall of the lipiodol along the spine is so rapid that it can not be examined fluoroscopically.

PATHOLOGIC CASES

We shall review briefly the easy cases wherein this method gives equally as good results as the radiographic examination after intracisternal injection, and then point out the superiority of this technic in cases of difficult interpretation.

(A) Easy Cases—Total Block.—When there is a total block of the subarachnoid space, the examination gives a suggestive result. The lipiodol globule first begins its normal course, and then, at a definite level, the elongated ball becomes deformed into a large opaque mass with transverse or curved lower border. If the block is cervically lo-

cated, the small drops of oil, having escaped from the thoracic segment, fall freely into the cerebrospinal fluid and stop suddenly in their course, and, after a few minutes, give a picture of the same shape. Through the accumulation of the drops, the upper border of the shadow remains for a moment polycyclic If such a picture of total block offers an accurate demarcation of the lower pole of the obstacle, the causal diagnosis of the block is not easy in every case. We base it on the anamnestics, the careful clinical examination of the patient, and the biological triad (Sicard):

(*a*) Chemical examination (protein) of cerebrospinal fluid;

(*b*) X-ray examination of the spine (especially lateral views);

(*c*) Lipiodol test.

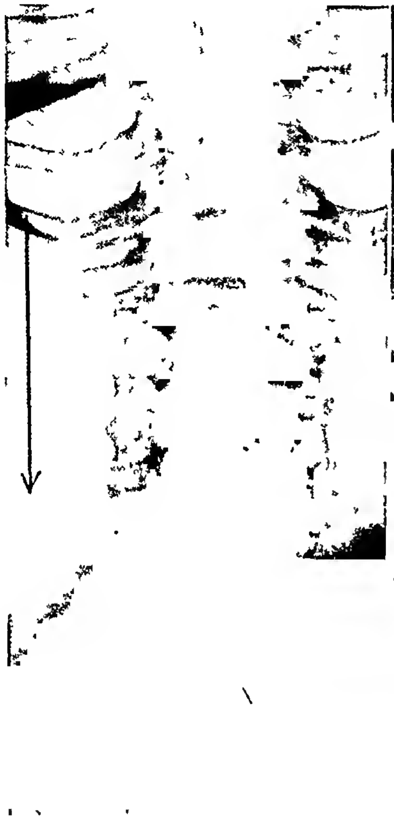


Fig 3 Complete spinal block by Pott's disease in a child Same technic as that described in Figure 2

Fig 4 Incomplete spinal block by arachnoiditis Same technic as that described in Figure 2 Droplets of lipiodol are retained at different levels

Intradural tumors, mostly benign (neurofibroma), produce generally a total block with a transverse or curved (cap picture) border. The tooth-like picture is also typical (Fig 2). *Adhesive spinal arachnoiditis,* the lesions of which may simulate cord tumors, gives different pictures, depending upon whether the lesions are localized or diffused. In the first case, the picture may be identical with that of a tumor showing a sharp transverse line, but, even in this case, we have been able to make the differentiation, as will be shown later on. At other times, local adhesive arachnoiditis gives a characteristic picture which may be compared in shape to the teeth of a comb. In the diffused forms, which may give the same

clinical picture, the lipiodol is dispersed into numerous drops, arrested by the subarachnoid veils at different levels, the remaining part being arrested completely a little lower down.

Vertebral Diseases Compressing the Cord.—Pott's disease, acute spondylitis, cancer, etc., may cause total block and the lipiodol picture may simulate that of a tumor (Fig. 3). But, generally, a careful clinical examination and a good roentgenogram of the spine will show the vertebral cause of the compression.

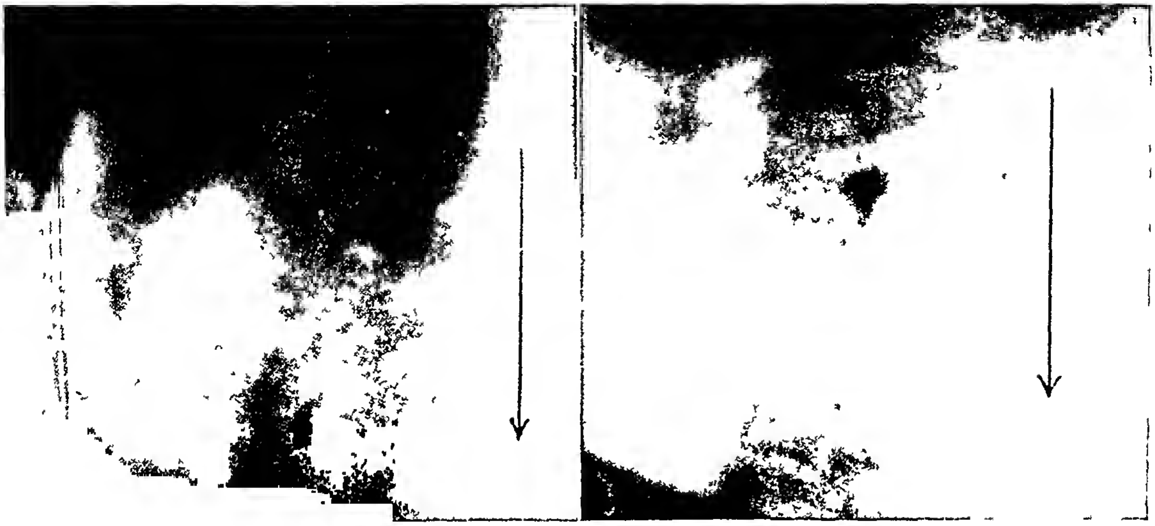
Partial Block.—There are two instances wherein most commonly the lipiodol ball is partially arrested in its course: (1) adhesive meningitis; (2) intramedullary tumors. In the first case, the shadow produced by the dissemination of the drops of lipiodol is similar to that spoken of above, but a part of the lipiodol will have reached the extremity of the spine (Fig. 4). In three cases of luetic arachnoiditis of this type we have watched the influence of the specific treatment by the progressive falling of the droplets, which had been first stopped in their course. In intramedullary tumors or syringomyelia the shadow cast by lipiodol consists generally in two elongated and festooned lines along each side of the spinal canal, which demarcate between them the fusiform shape of the enlarged medulla. Of course, all the diseases causing complete block in an advanced stage of their evolution can cause a partial one at the beginning.

(B) Difficult Cases.—These cases are mostly represented by compressive conditions of the cord at the beginning of their evolution, when the spinal block has not been completed. The question arises, then, whether the neurological symptoms detected by clinical examination are to be attributed to an intrinsic disease of the spinal cord or to an extrinsic cause—tumor, arachnoiditis, or disease of the vertebræ. In these cases the fluoroscopic examination of the lipiodol transit seems to be far superior to the other method, because of the possibility of detecting some abnormality in the course of the oil which might be overlooked in a radiogram. Here is an example: A man of 69 came under our care for radicular pains of the left first thoracic segments, irradiating along the intercostal spaces. On examination there was noted a small irritation of the pyramidal path, occasioning a suspicion of cord compression. The first radiogram failed to reveal any vertebral lesion. Manometric tests of the subarachnoid space after cistern puncture seemed to indicate a partial block. Lipiodol (1.5 c.c.) was injected into the cisterna magna and a radiogram taken a few minutes later. It showed that the lipiodol had fallen down normally with the exception of a few drops which were arrested at the level of the first thoracic vertebra. Such a picture could not lead to any definite conclusion of spinal block. The next day the patient was put in head-down position on the tilting table and the same ball of lipiodol could be watched on the fluoroscope, progressing reversely. It then became obvious that a definite, though transitory, stoppage was to be seen at the level of the third thoracic vertebra. The further evolution of the case proved it to be a Pott's disease involving the first and second thoracic vertebræ.

From the report of twelve recent cases we can state that by employing the lipiodol test, under fluoroscopic control, one is able to detect spinal block at an earlier period of its evolution than by any clinical or manometric test. Furthermore, it is the only examination which affords direct localization.

We believe that in the cases quoted at the beginning of this article (Guillain, Babinski), the early detection of the spinal block would have been rendered possible had the lipiodol transit been examined fluoroscopically. Slight abnormalities would not have been overlooked and an early diagnosis

would have been arrived at. On the other hand, it has been asserted lately by Christophe (of Liege) and a few others that a complete arrest of the lipiodol does not give full certitude as to the presence of a spinal block at this level, and he has reported two cases in which laminectomy did not show any material obstacle. In discussing these questions we must point out, first, that such a conclusion as that reported by Christophe must not be drawn too quickly, even after an operation. It is quite possible that a vertebral disease showing a positive block with lipiodol might not be disclosed during the laminectomy. Such a case has arisen several times when a lesion of Pott's disease (De Martel), a cancerous nodule (Wartenberg), or a spondylitic abscess in the body of a vertebra has shown a definite lipiodol arrest, and yet could not be detected in the course of the operation. In these three cases the correct diagnosis was made only at necropsy, and it was at first claimed that the lipiodol test had led to an erroneous opinion.



Figs 5-A and 5-B. Incomplete spinal block in a case of vertebral disease. Fig 5-A, first radiogram taken during the passage of the oil along the obstacle Notice the curved lower limit of the principal mass of lipiodol Fig 5-B, five minutes later: The typical picture of block has disappeared; only a few droplets are still retained.

The report of another of the writer's cases may illustrate this point. A man of 54 was admitted at Hospital Necker complaining of pains in the right shoulder of three months' duration Not the slightest objective neurological symptom was to be detected. The lipiodol test was performed after cistern injection and the radiogram showed that the oil, which was all collected in the lumbosacral cul-de-sac, failed to reveal any block. The next day the patient was examined on the tilting table and the transit of the lipiodol, previously injected, watched fluoroscopically. A partial but definite stoppage, with a curved border, was reported at the level of the fifth cervical vertebra. This stoppage did not last more than five minutes, after which only a few droplets were retained, the rest of the oil having passed, drop by drop, and reached the cisterna (Figs. 5-A and 5-B). When the patient was put again in the erect position the lipiodol fell down promptly to the lumbosacral cul-de-sac and no definite stoppage could be detected on its course. The lipiodol test on the tilting table was made several times with the same globule of lip-

Fig. 6. Complete spinal block by intradural tumor (neurofibroma) detected by cistern and lumbar injections of lipiodol. The patient had been placed in head-down position at an angle of 50 degrees. Nevertheless the mass of lipiodol, sticking to the cephalic limit of the tumor, had remained *in situ*. The contour of the tumor is definitely defined. (Patient of Dr. Alajouanine.)

iodol, the patient being put in supine or oblique posture. Each time the same stoppage was noticed, giving evidence of a partial but positive block. After an unsuccessful deep X-ray treatment, laminectomy was performed, at which time the cause of the block was not apparent to the surgeon. But three months later, the condition growing worse, an X-ray examination of the cervical column revealed a partial destruction of the fourth cervical vertebra. The patient died from paraplegia. Unfortunately necropsy was not permitted.

Another difficult point in diagnosis which may occur in the case of spinal block is differentiation between adhesive arachnoiditis and any other compressive cause. Of course, this happens only when the shadow cast by lipiodol does not belong to any of those which permit a strong suspicion about the causal diagnosis. The best way to settle the question is to examine the transit of lipiodol in both directions, from the occiput to the sacrum and reversely. If the distance between the upper and lower limits of the compression exceeds one or more vertebral bodies, the possibilities are in favor of an intradural tumor or a vertebral disease (Fig. 6). Furthermore, when this distance extends over more than two vertebræ, an extradural compression (epiduritis, epidural tumor, vertebral disease) may be anticipated; *on the contrary, when there is little* or no distance between the upper and lower limits of the compression, the probabilities favor arachnoiditis. In such cases the same procedure is advised to rule out the possibility of a non-pathologic obstacle. When the arrest of the lipiodol is due only to its adhesion to the inner surface of the dura, in addition to the special form of the image, the oil, sliding from the occiput to the sacrum, may stop at the same level or somewhat lower than when the globule is examined during its transit in the opposite direction.

The delimitation of the upper and lower limits of the obstacle may be made with one injection of lipiodol, in case of partial block, the patient being examined in the erect, and then in head-down position. When a total block is present, two lipiodol injections must be performed—through the intracisternal and the lumbar routes. The latter can be an injection of light lipiodol (examination in erect position) or ordinary lipiodol (examination in head-down position).

In closing, we must emphasize that the long period during which lipiodol remains movable in the cerebrospinal fluid affords time for repeated examinations of its transit on the tilting table.

In a case reported by Babinski, the same globule of lipiodol which had travelled freely downward along the spine immediate-

ly after an intracisternal injection, was movable enough three months later to permit of another examination, and the patient being put in head-down position, a spinal block, then completed, could be demarcated.

CONCLUSIONS

1. The best technic for the lipiodol test of the spinal subarachnoid space is the fluoroscopic technic.
2. This examination can be performed after lumbar injection of lipiodol, the patient being put in the head-down position on a tilting radiologic table.
3. Radiograms should be taken in the course of the fluoroscopic examination, when definite abnormality of the transit is noticed. The position of the patient should not be changed for the taking of the radiograms.
4. The use of this technic of radiographic diagnosis reduces mistakes in localization of spinal cord compressions practically to *nil,* but the diagnosis of the cause of the compression may be difficult in a limited number of cases. Exhaustive clinical and X-ray examinations, together with repeated fluoroscopic examinations with the same globule of lipiodol, may succeed in elucidating a certain proportion of difficult cases.

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DISCUSSION

Dr. L. R. Sante (St. Louis): Since Dr. Forestier's first paper in this country we have seen three spinal cord tumors localized by this method and operated on successfully. In all of these cases we were able by the lipiodol injection to localize the real lesion, an actual tumor, as much as two or three sections higher than neurological signs indicated.

I have recently had a case in which the lipiodol, in place of flowing to the lower portion of the spine, separated into two elongated strings. The case had been considered as one of transitory myelitis because of the fact that the patient was definitely paralyzed. Involvement of the upper extremities, with partial paralysis and the presence of sensory symptoms, together with fever, led us to a diagnosis of acute poliomyelitis. Other indications led us to a consideration of the possibility of the lesion being a tumor. The patient has not yet been operated upon.

I wish also to call attention to the question Dr. Hickey spoke of—the failure to observe absorption of lipiodol in the spinal canal. Of course, if the patient is operated upon, and if a tumor is removed, the lipiodol escapes, but if no pathology is found the lipiodol sinks to its lowest level and finds its way to the terminal branches of the nerves and spreads out along the cauda equina. Now I understand that the Ciba Company has recently put out an iodinized oil preparation called "lipiodine," which is to be injected in like manner to lipiodol, and that the makers claim it will be absorbed in the spinal canal. I wish to ask Dr. Forestier whether or not he thinks the claim is well founded.

CASE REPORT

MYELOSARCOMA

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Multiple myeloma is of relatively rare occurrence, only about 140 cases being on record. These cases are mostly among males, between 40 and 60 years of age.

Myelosarcoma, malignant variety of the same tumor group, is even less frequent. The main point of difference is the invasion of the periosteum, infiltrative growth through the bone substance, with formation of visible lumps, as illustrated by the following case.

Fig. 1. Patient at the time of the operation.

A man 70 years old, apparently in good health, presented himself on September 1, 1927, referred by Dr. R. C. Willett, of Peoria, Illinois, with the following history: Seven weeks previously he had had a lower right bicuspid tooth extracted; three to five days later a tumor developed on the alveolar ridge near the ramus, extending forward to the point of extraction. This was said to be due to irritation of the last molar in the upper denture. The tooth was removed but the swelling progressed until it extended almost to the posterior surface of the angle of the mandible. About ten days before examination an incision had been made to evacuate pus, but there was no pus. A week before examination a fracture of the mandible was discovered. When he was seen by us there was no induration and no glandular involvement but the tumor had a rather doughy feeling. X-ray examination by Dr. F. J. Ronayne showed a large cavity in the body of the mandible amounting to almost total destruction at the site of fracture. The rarefied area was limited, similar to that of a cyst, but there was no dense bone surrounding it as in a cyst. The remaining bone had a mottled appearance. The patient also presented a small swelling of similar consistency between the external canthus of the left eye and the auricle, extending from the upper border of the zygomatic arch into the temporal region. Gastric findings were negative. Spleen was palpable; liver slightly enlarged, with rounded borders; no palpable retroperitoneal or other lymph nodes; prostate negative. There was no albuminuria, no Bence-Jones protein in the urine. The blood picture showed no evidence of leukemia.

Operation revealed malignancy. We cleaned out the mass and packed the cavity. There was a troublesome hemorrhage. Color of the tumor on the cut surface was dark red. Microscopic examination during the operation showed large round cells, many in process of mitosis, suggesting myelogenous sarcoma—in other words, a pri-

Fig. 2. Skull, showing extensive involvement of the bones, with destruction of the outer layers.

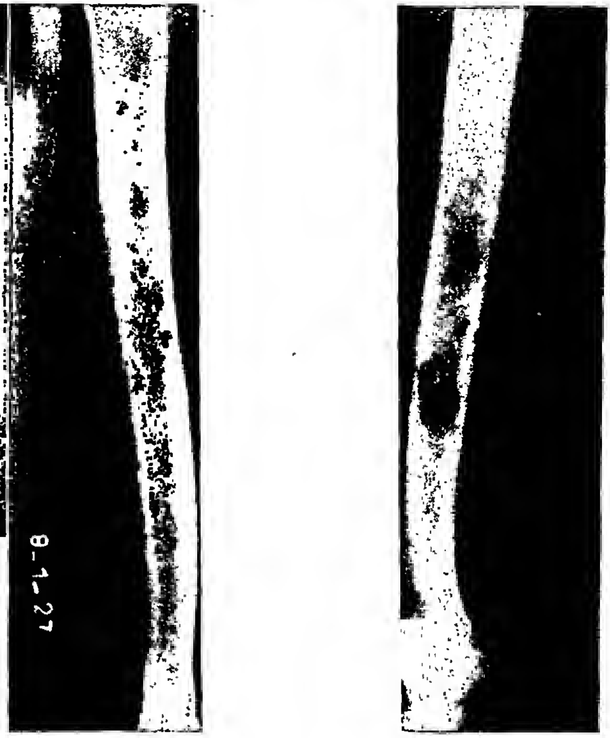

Fig. 3. Involvement of the humeri.

mary multiple malignancy of the bone marrow. Therefore additional X-ray examination of the skeleton was made, revealing another cavity on the left side of the mandible like the one described on the right and also involving the spongy substance. Likewise, multiple lesions in both maxillæ, the skull, both humeri and femora, some sug-

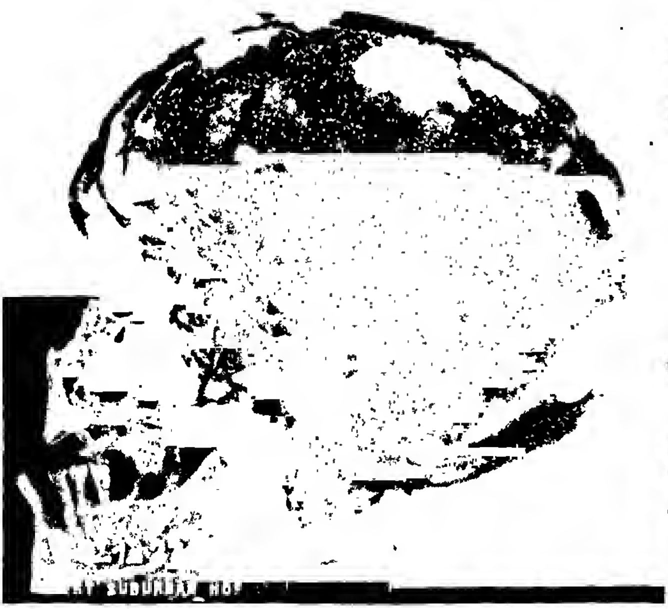

Fig. 4. Skull, lateral view.

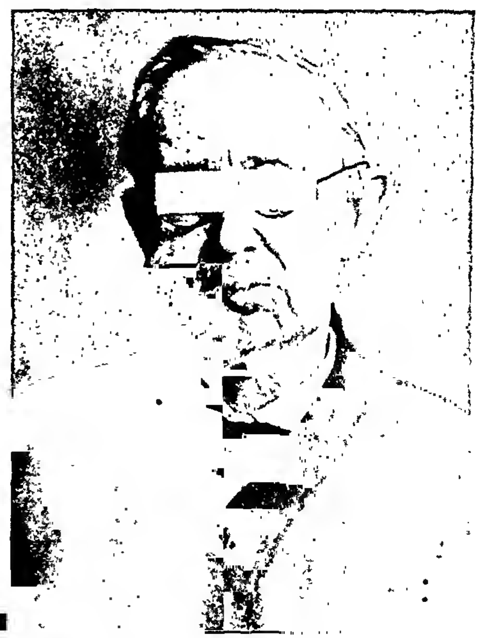

Fig. 5. Patient two and a half months later.

gestive spots in the clavicles, at the tip of the sternum and in the lungs were found. (See Figs. 1–4.)

The photograph made about two months after the operation (Fig. 5) showed the increased swelling in the mandibular area, and the increase in size of the swelling in the temporal region on the opposite side. (See Figs. 5–7.)

Fig. 6, *above* Patient five months later.
Fig. 7, *below* Patient five and a half months later.

Microscopically the tumor consists of one kind of cell—a rather large round element, about 14 to 18 microns in diameter, with round, somewhat eccentric nucleus and well developed cytoplasm. The nucleus contains, as a rule, a well developed central accumulation of chromatin and a ring of small particles on the periphery, resembling, therefore, the nucleus of a plasma cell. Some cells contain two nuclei. Numerous mitoses are plainly visible. The cystoplasm does not contain any granules on the sections stained with hematoxylin-eosin or with methylene blue or with Wright's. No reticulum cells are found. The connective tissue stroma of the tumor is scant. The tumor is well supplied with small vessels. Numerous foci of fresh hemorrhages, as well as intracellular deposits of hemosiderin, are scattered all over the section. In superficial layers a few isolated *Mastzellen* are found, in some places located among the tumor cells, but apparently not involved in the neoplastic process.

Therefore, from the histopathologic point of view, the tumor should be classified as malignant plasmocytoma. There is no evidence of neoplastic activity of other hematopoietic cells, as is sometimes observed in cases of benign and malignant myeloma. Peculiarly enough, the blood picture is never affected by neoplastic activity of bone marrow in myeloma.

The patient was advised to have X-ray treatment, as it is supposed to control the course of myelomas better than other neoplastic growths. Instead, he decided to try out "cancer cure" treatment, pretentiously, boldly, and extensively advertised within recent months. Figures 5, 6, and 7 show the results of this "treatment," indicating an extremely rapid progress of malignant involvement. He died eight months later.

EDITORIAL

THE SIGNIFICANCE OF POSTMORTEM EXAMINATIONS IN THE TRAINING OF ROENTGENOLOGISTS[1]

When one specialty in the practice of medicine urges consideration of its field as a requisite for the training and well-being of any other specialty, such recommendation may closely border on presumption. For every unit in this increasingly departmentalized army of modern medical science naturally concludes that it, itself, is best fitted to determine the standards of its education as well as the extent of its liaison with each of the other units.

In no other group is this conclusion more easily justified than in that specialty designated as roentgenology. The bulk of the knowledge on which the training of its individual devotees rests is embodied in the facts of a science hardly at all related to that of medicine, namely physics, from the study of certain aspects of which, medical radiology may be said to be merely a by-product or offshoot. A knowledge of the laws governing electrical currents and reactions, the construction and installation of apparatus according to these laws, and the principles underlying the production and control of the roentgen rays constitute the armamentarium of the radiologist. The utilization of this knowledge in the domain of medical diagnosis and treatment is largely a matter of repeated experiences, gained more rapidly under the tutelage of a master but nevertheless dependent largely on repeated observations in which, contrasted with pictures of the normal, pathologic variations become readily recognizable and in the main of easy and accurate interpretation.

So simple and quickly acquired is much of this training that non-professional technicians are often enabled to obtain considerable recognition of their ability, and in some hospitals and medical clinics have taken no small part in diagnosis and treatment. It is often, and perhaps properly, urged that surgeons, internists, pediatricians and the other specialists should study as a part of their essential training the proper interpretation of X-ray plates as it affects their special fields, and there are those who would advocate that by this means the need for professional roentgenologists is eliminated, and that, if the specialist keeps well abreast of his calling, the trained X-ray technician is the only necessary addition to his staff. With the development of every new division in medical practice this same attempt has been made to decry its necessity, and, while the specialist in roentgenology, as in other branches, must continue to protest against this assumption, he does not need to view the situation with alarm. For the medically trained roentgenologist has long ago justified his calling, and the dignity and worth of his special attainments have found a permanent place in the already large galaxy of unicentric medical stars. The reason for this is clearly apparent. By his knowledge of anatomy and physiology the professionally trained specialist more easily recognizes deviations from the normal, and

[1]Read before the Thirteenth Annual Meeting of the Radiological Society of North America, at New Orleans, Louisiana, Nov. 28–Dec. 2, 1927.

by his comprehension of the signs and symptoms of disease, he can utilize his anatomic and physiologic knowledge more correctly to apply and interpret the purely mechanical phases of his science. He thus, with all other branches of our profession, becomes a practitioner of the science and art of medicine and deserves and should receive full recognition as a medical consultant.

After all these premises have been granted, it must naturally follow that among professional roentgenologists the prerequisites and requisites for proper training must be determined largely by themselves, and again the presumption is apparent when members of any other group urge special consideration of this or that branch of medical practice as of more than its usually recognized value. To be more specific, while the need for a knowledge of pathologic conditions is well recognized in roentgenology, as well as in other divisions of medicine, in the minds of many no special emphasis on this need is recognized or admitted. Why this fact should apply particularly among many X-ray workers is readily understood when one examines the character of the large bulk of their work. For example, in evaluating the lesions of bones, most of the pictures are sharp and clear-cut and "he who runs may read" them. Further knowledge is readily acquired, first under tutelage and later as the operator's knife discloses the final nature of the disorder of the bony structure. Even in the more difficult fields of urologic and gastro-enterologic diagnosis, precision in the art becomes increasingly easy as mistakes and successes are both revealed by the surgeon. Foreign bodies and diseases of the central nervous system are likewise often checked by operation; even in the thorax, where conditions ordinarily comprise the field of the internist, skill in the use of the aids to physical diagnosis as well as the progress of the disease constitute reliable confirmation of the interpretive art of the roentgenologist.

Consequently when the pathologist, enthusiastic supporter of the importance of his special field, urges the roentgenologist to attend postmortem examinations, and to give extra attention to a study of the gross and microscopic evidences of disease, such pleas are quite likely to fall on barren ground. It will be readily granted that everyone engaged in the practice of medicine should have a fundamental knowledge of the causes and effects of morbid processes; that is the reason a course was taken, amid much travail of mind and body, in a medical school. But once entered on the practice of the chosen field, our study is transferred from the cadaver to the living body, from the final stages of pathologic conditions along the entire gamut of their development. In short, for the purpose of ending a disagreeable argument and at the same time effectually silencing the pestiferous pathologist it is announced with emphasis that henceforth our activities are to be devoted to the study of living pathology, in which study, it is implied, the postmortem room and microscopic sections of dead tissues can play only a very minor rôle.

I have purposely exaggerated and to a certain extent misrepresented the situation in order to give more prominence to a program which is so sound and rational that the tricks of propaganda are hardly needed to establish its worth and ready acceptance. That the "checking up" of roentgenologic as well as other diagnoses at a surgical operation, furnishes most valuable training is granted by all without argument. That a similar checking up at a postmortem examination provides accessory but equally valuable training is also generally freely admitted. But not so commonly practised is the extended utilization of postmortem examination for more complete studies on the physical characters of disease, whether such

disease has reached the level where it produces physical signs and symptoms or rests still submerged and a witness of minor processes checked or held in abeyance, or of potential conditions which would have menaced the future of the subject if he had survived. The storms which beat on the human body leave such paths of destruction and such changed geographic contours that to the trained clinician and pathologist, the searching for these and the endeavor to interpret their meaning is an inestimable privilege. No less a boon are such fields for the resourceful student of roentgenology. Not only can he see the various stages of pathologic processes and their interrelated effects, but an unexcelled opportunity is offered to study new technical methods whose aim is to enlarge the boundaries of the usefulness of roentgen rays to the living.

To the roentgenologist the technical and scientific problems which remain to be solved are legion, and as the field is comparatively new the solution of many of these questions lies "right around the corner." At the postmortem table are many keys to the puzzles which surround him, as well as a vast storehouse of fundamental anatomic and pathologic data.

For example, in the abdomen, while the presence of calculi and dilatations and distortions of the urinary tract are deduced with a fair degree of accuracy, the outline and other changes in the solid substance of the kidneys is still largely an unknown field. Recent attempts to surround the renal capsule by a layer of air and thus determine its contour have not yet reached a justifiable stage of development, but a beginning has been made and the postmortem examination may furnish a splendid field for effecting a final solution. Special substances in the blood stream which will intensify the renal shadow, or the filling of the perirenal tissue spaces by other materials may disclose a harmless and extremely useful procedure. In the question of abscesses, tumors, and other changed consistencies of the renal tissues, testing of the removed organ by varying sensitiveness of plates and varying factors of exposure might show properties of diseased portions which, by more careful technic and at other than the usual angles of exposure in the living body, may reveal phenomena of renal change, as yet adjudged incapable of demonstration. It is quite possible that we have too readily accepted the general opinion that only by gases, foreign bodies, lime salts or artificially introduced substances can the various normal and pathologic tissues be differentiated. The slight but definite variations of the shadows produced by abscesses *versus* tuberculous caseation, by tumors *versus* normal tissues, by hilus blood vessels *versus* cortical capillary zones, to mention only a few of these phenomena, present a field of study and research which may still yield much valuable data.

In the gastro-intestinal tract many thousands of roentgenograms are taken daily, following "drink this, please," or the forcible injection in the reverse direction of semi-fluid suspensions of a cement-like substance. But how few attempts are ever made to trace at postmortem the conditions revealed by these pictures or to study the abnormal physiologic mechanisms which were thus crudely analyzed? In the interests of both the patient and the surgeon, better and even safer mediums may be desirable, and, if this is true, the exposed tract, free to inspection and manipulation, offers the most feasible means of testing by the trial-and-error method, the efficacy of new suggestions.

In the diagnosis of duodenal ulcer by the roentgen rays remarkable advances have been made in recent times, and we are all proud of what has been accomplished in this field. But we cannot afford to remain content with the progress thus far achieved. The

extent of duodenal distortion, the question of healed *versus* active ulcers, the changes in the pylorus and the resulting deviations from normal physiologic processes in both stomach and duodenum, as well as small intestine, demand more clearly evaluated data and perhaps even different methods of approach. The surgeon can check the diagnosis, but only at postmortem can many of the problems be studied in their various phases and more valuable means for elucidation be given preliminary tests.

In the diagnosis of gallstones and cholecystic diseases, in spite of new methods, no one can assert that we may be wholly satisfied with the results of either purely clinical or roentgenologic attacks. If we admit, as we must, the possibility of the existence of "silent" collections of calculi in the gall bladder, silent because they are not associated with any demonstrable inflammatory phenomena and because they do not cause any appreciable subjective disturbances, then the proper evaluation of their presence as pathologic factors becomes even more difficult. Perhaps in this field roentgenology has gone as far as advisable, but it would be exceedingly unwise to state this as a fact. The mapping of the outlines of the gall bladder, and their relation to neighboring organs is an end "devoutly to be wished" and in the solution of this problem the roentgen rays will undoubtedly play a major rôle.

In the study of the chest, roentgenologists are furnishing absolutely indispensable aids to the proper interpretation of pathologic conditions. The organs of the thorax, with their comparatively thin outer envelope, the chest walls, with the light, mobile, air-containing lungs and denser heart and large blood vessels, are admirably adapted to reveal even minor alterations in activity or structure. Therefore it becomes all the more necessary that the true nature and meaning of these alterations should be known by every one who presumes to express any opinion on disease processes within the chest. Follow your fatal cases to the postmortem examination and do not fail to analyze the facts there revealed in relation to the shadows on the "chest plate." Even better, take plates of the chest before the body is opened, and then, after removal of the lungs, inflate these artificially and again test with more exposures the meaning of the lesions which are seen. The more extensive such a series of studies becomes in any X-ray department, the more intelligent will be the opinions which emanate from that particular source. Moreover, the chest lends itself admirably to the search for solution of many problems. For example, how much fluid must a pleural cavity contain, before it will be clearly revealed, and what is the regular distribution of this fluid? What is the effect of respiratory movements on this fluid and how do its different densities affect the shadows? Of what significance is the fixed or mobile mediastinum? In the normal lung what produces in the roentgenogram the striations running out from the hilus? Do these represent bronchi, blood vessels, or both? The effects and various distributions of opaque substances, such as iodized oil, the diaphragmatic outlines and mobilities, the heart's diameters, and the questions arising in spontaneous as well as therapeutic pneumothorax are only a few of the problems which require further study and elucidation. It is true, of course, that the inert dead body is not a replica of the pulsing, breathing, tense, living machine, but many of the phenomena of life can be passably well imitated by artificial means, and, even with admitted limitations, the advantages offered at necropsy are too important to be ignored.

With the skull and its contents we have to consider a field of roentgenology where discouragement has largely marked efforts at advancement, either in technical methods

or interpretive skill. In the normal skull, mapping of the bony sinuses, sutures and foramina and the outline of the sella turcica represent almost the outer limits of usefulness. In the presence of disease, as it affects the bony structures, fairly conclusive diagnosis is possible, but as it affects the brain, conditions are distinctly unsatisfactory from the standpoint of the roentgenologist. Ventriculography, the most outstanding recent accomplishment, is not yet on an assuredly safe basis, and in the differentiation as well as the location of tumors, abscesses, and hemorrhages, we are still largely dependent on the interpretive skill of the neurologists. Here indeed is a place for research, full of difficulties but rich in the reward of accomplishments. The shadow-producing effects, and methods of introduction of gases or opaque fluids into the subdural and subarachnoid spaces, the feasibility of cutting "windows" on opposite sides of the calvarium for trans-exposure, as well as the possibility of the circulation of various dyes needs patient inquiry. Much of this may be performed at postmortem, where the value of anthropological studies alone would make the taking of many plates a fully justifiable procedure.

But my thesis has already been perhaps unduly expanded. The field of endeavor presented is large and generous. The pathologist is usually more than willing to cooperate. Will not the roentgenologist fall short of his duty and privilege if he does not seize these opportunities? We, as physicians, owe it to the living that our deaths shall not be total losses.

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EDUCATION IN MEDICAL RADIOLOGY, WITH REFERENCE ESPECIALLY TO THE EXPERIENCE GAINED IN SWEDEN

INTRODUCTORY ADDRESS, READ BEFORE THE SECOND INTERNATIONAL CONGRESS OF RADIOLOGY, STOCKHOLM, JULY 24, 1928, BY

PROF. DR. GÖSTA FORSSELL

That radiology has become a separate department in medicine, and has built up institutions of her own, is due to the practical demands of medical science.

Within the field of medical radiology, research work and the purposeful systematic exploitation of each new experience gained have gradually widened the scope of *roentgen diagnostics* and *radiotherapy* to such an extent that those two branches have by now grown into separate, special sciences, each of them widely embracing and exacting enough to claim the full attention and energy of whoever devotes himself—or herself—to its pursuit.

In the same measure as radiology has become more and more indispensable to practical medicine, and as the problems it has been called upon to solve have become both larger and deeper, it has also become more and more evident, both to those who represent the practical side of medical science and to the universities, that a *special instruction and training* in radiology is necessary, not only for the physicians who aim to become specialists in that branch, *but also for the practitioners in those various branches of the medical profession where radiology plays an important accessory part.* At last it is becoming realized that radiology has become so important to medical science as a whole, and so firmly established as a distinct, separate department of that science, that *a systematic presentation of the subject should be made a part of the general medical education.*

In most countries, the universities have therefore given radiology a place, larger or smaller, as a subject of teaching, and each year adds to the number of medical faculties in which radiology is recognized as a separate branch of regular medical instruction. In most countries it is no longer a question *whether* radiology should be given a place as a special subject of teaching, but only *how* that teaching should be organized.

The question of the best forms for teaching and training in medical radiology is the subject of discussion everywhere. The practical organization of such instruction can be arranged only with regard to the particular conditions obtaining in each individual country. Thus, the instruction in radiology will have to be planned in due correlation with *the rest of the country's system of medical education,* and with regard also to *the organization of nursing there.* The foremost factors to be considered are: What *competent teachers and instructors* can be obtained; how the country stands with regard to *scientific and practical development of radiology,* and what *economic resources* are available for the purpose.

With regard to all those factors, the conditions are exceedingly unlike in different countries, and even in different places within the same country.

If this Congress has nevertheless decided to make the question of instruction and training in medical radiology the principal topic of its program and work, and has invited the teachers of that specialty from the different countries to contribute the results of their experiences to a joint volume on the subject, it has been done in the hope that the sum of those experiences, reaped by them in the school of practical life, may give us a fuller general view of what particular requirements the instruction in radiology is apt to make, owing to the special character of that science; and to find out something about the best forms for such instruction, and what would be, in a general way, the best and most fruitful basis for its organization.

The topic of my own remarks on the subject will be on the manner in which we, here in Sweden, are trying to solve the various problems involved with the task of organizing the teaching of medical radiology.

Since 1914, the Caroline Medical-surgical Institute here in Stockholm has organized regular courses in roentgen diagnostics and roentgen technic. The courses were optional for the students. Since 1920, similar courses have been instituted at the Faculty of Medicine of the University of Upsala, and since 1923 at the University of Lund.

By a Royal Decree of Nov. 16, 1923, roentgen diagnostics was made *a compulsory subject* for the medical students in all the Swedish universities, and last year, in 1927, a parliamentary decision made *medical radiology a recognized special department of medical education and teaching.* Ordinary lecturers in medical radiology were established at the universities of Upsala and Lund, while at the Caroline Institute, where a personal professorship had been established in 1916, its holder was raised to the rank of an *ordinary professor in medical radiology.* All the teachers in radiology are at the same time senior physicians in some radiological institution, and have at their side assistant physicians appointed by the University, besides the necessary staff of nurses and hospital attendants. It would be contrary to the idea and spirit of the Swedish universities to have the scientific work of an important special department directed by men representing some other branch of science, and executed by changing assistants without any special training for their task.

The teaching of medical radiology is arranged in a manner which gives that branch a *character entirely its own* within the plan

of medical instruction otherwise obtaining in Sweden. As far as other medical subjects are concerned, the university teaching is limited to the general lectures and courses common and compulsory for all the students, while the training in the specialties must be obtained entirely through practical service as assistant physician or amanuensis in clinics and theoretical institutions. Only with regard to medical radiology does the teaching by the university comprise both the compulsory courses common for all the students and voluntary continuation courses combined with practical exercises, and service as medical assistants for practical training.

Finally, there exists with regard to radiology, more than with regard to any other branch, a co-operation in the matter of teaching between the institution for radiological teaching and the other clinical institutions.

The compulsory course of instruction is given during the early part of the student's clinical terms, after he has seen service for three or four months in some of the large clinics. Its object is to give all the students a systematic presentation of the subject of roentgen diagnostics; that is, of the science dealing with the anatomical structure of the human body as it appears in the light of the roentgen ray. This course is given in twenty lecture hours during a period of six weeks, and is taken by the student at the time of his clinical service in the medical or surgical department. The number in each class is from thirty to sixty. The instruction is given in the form of lectures, with demonstration of roentgenograms. Examinations do not form a part of this course as yet; but it is desirable that they should be introduced.

During the students' four years of service in the clinics they have daily occasion to see the demonstration of roentgen findings by the clinical teachers in connection with the clinical lectures and demonstrations, at the same time as they themselves, during their service as clinical assistants, take part in the daily conferences at the central roentgen institute.

The voluntary continuation courses in medical radiology are taken at the end of the student's time of clinical service, shortly before the final examinations; consequently, after from eight to ten years of medical study. Their object is partly to give a presentation of medical radiology as a whole; that is, of the science dealing with the various forms of radiation in the service of medicine; and partly to give some practical training in roentgen diagnosis and roentgen technic. They are intended as a preparatory school for those who wish to devote themselves to radiology or some branch of that science, and also for physicians who may be going to take up service in some minor hospital, to which no special radiologist is attached.

The full course occupies about forty-four lecture hours, and extends over two months. It consists partly in laboratory exercises in the interpretation of roentgenograms, partly in lectures—with demonstrations—on specially chosen parts of the roentgen diagnosis and the elements of radiobiology and radiotherapy. The number of attendants of each continuation course is limited to twelve.

Simultaneously with the course, the students—divided into groups of three—receive practical instruction in roentgenography and fluoroscopy. For some of them an opportunity is provided to take part, as assistant physicians, in the work at the central roentgen institute of the university.

The problem of special education in radiology is made easier in Sweden by the fact that—thanks to a discerning organization—practically all of the roentgen work in our country is confined to the hospitals, and that, in the larger of these, all the roentgenologic work for the whole hospital is cen-

tered in one central roentgen department under the direction of a first-class, thoroughly trained radiologist, who has his entire work—even his private practice—in the hospital.

In the smaller hospitals, the radiologic work is confined to roentgen diagnosis, and is taken care of by one of the physicians—either the chief physician himself or one of his assistants—who has had a training in the work.

The practice of roentgen therapy is confined to such hospitals and special departments as possess a radiologic clinic headed by a specially qualified radiologist. The treatment of malignant tumors by radiotherapy is done almost exclusively by two well equipped radiotherapeutic clinics: one—the Radiumhemmet in Stockholm—for the northern and central parts of Sweden; the other—the Radiotherapeutic Clinic at Lund—for the southern part of the country. A third center of this kind, for the western part of Sweden, is projected, and will be located in Göteborg.

What places the education in roentgen diagnostics in a class of its own is the fact that roentgen diagnostics, on the one hand, as a science apart—like histology, which, as far as the teaching is concerned, is the branch it most nearly resembles—requires teachers and institutions of its own in order to deal with such subjects as roentgen anatomy and roentgen physiology, both as matters of research and of instruction; while, at the same time, it must fill a place as accessory science to all the other practical and theoretical branches of medicine.

The education in roentgen diagnostics, in Sweden, has to answer a twofold practical purpose: that of providing the most comprehensive and thorough preparation and training possible for the men who are to become chiefs of the central roentgen departments of the large hospitals—that is, the radiologists; and of providing facilities for the specialists in the various branches of medicine to carry out scientific research and to perfect themselves in whatever particular part of roentgen diagnostic work their specialty demands.

The realization of that double purpose has to overcome two difficulties with which the ordinary education in anatomy and pathology does not have to cope, but which are the result of characteristics inherent in the nature of roentgen diagnosis itself. The first one is the fact that roentgen diagnosis is *living anatomy*, whence it results that the roentgenologist, as physician, has to get into contact with the patient. The roentgen diagnostic work must, therefore, take place right in the clinical hospital, and in constant touch, on the one side, with clinics and policlinics, on the other side with the pathologic institution. The second difficulty with regard to roentgen diagnostic instruction and research arises from the *economic problem*—from the fact that the scientific conduct of roentgen diagnostic work requires a great deal of very expensive special apparatus, which soon becomes antiquated, besides expensive housing and a numerous staff of specially trained assistants.

In the special clinics of the large universities abroad it is possible—and perhaps also necessary—to maintain fully equipped special departments for roentgen diagnosis, with roentgenologists and staffs of their own. Here, in Sweden, a dividing up of the roentgen diagnostic work in that manner would be impossible on economic grounds alone, and, besides, we hardly believe it to be desirable, either for the scientific work or for the instruction in roentgen diagnostics. The system we had to create was—as stated above—to serve a twofold purpose. It must provide complete facilities for scientific research and education in roentgen diagnostics *as a special branch*, and, at the same time, it must offer the best conditions possible for radiodiagnostics, *as an accessory science*, to

serve the other branches of medicine, both with regard to research and teaching.

We have tried to solve this problem mainly in two ways: partly, by organizing and equipping a central institution of education in radiology in such a manner that it can serve as special center of research and instruction for all the clinics, and partly by establishing a steady collaboration with the clinics, both for research and teaching, according to the American system.

In the plans that are being made at present for a new home for all the various departments of the Caroline Institute, the central department of instruction in roentgen diagnostics is placed in the middle of the building that houses the medical, surgical, otolaryngologic, ophthalmologic, and gynecologic clinics, and comprises three laboratories for routine work, and six laboratories for special research. Besides those, there will be smaller laboratories, both for current work and for special research in connection with the medical, surgical, pediatric, and orthopedic clinics, and with the medical policlinic. Roentgen laboratories are planned in connection with the anatomic, physiologic, pathologic, and lego-medical departments. It is the intention also that instruction in the theoretical branches of roentgenology shall take place in intimate co-operation with the central department for instruction in roentgen diagnostics.

Radiotherapy is the science that deals with the application of light, in all its various forms, to the service of therapy. It comprises radiumtherapy, roentgenotherapy, and heliotherapy.

The special education in radiotherapy derives its peculiar character from the fact that the scientific exercise of radiotherapy presupposes the possession of a scientific training in a number of special disciplines that do not form any part of the ordinary, general medical education, namely, radiobiology, radiopathology, and radiophysics. Besides, the special education in radiotherapy requires the existence of a special institution, namely, a radiotherapeutic clinic.

Inasmuch as the exercise of radiotherapy in Sweden is practically confined to the central radiological departments of the hospitals, to the radiotherapeutic clinics in Stockholm and Lund, and to a few special departments for radiotherapy—one gynecologic and another for skin diseases—the special education in radiotherapy in Sweden has the task of training physicians for those radiotherapeutic institutions. The instruction is obtained through service—usually for a period of two years—as assistant in the radiotherapeutic clinic of the Radiumhemmet in Stockholm, the radiotherapeutic clinic of the University of Lund, or the central roentgen institutes of the universities. Previous to entering on this course of radiological training and study, the radiologists have usually done post-graduate service for at least two years in either a surgical or a medical clinic. The complete radiological training, in diagnosis and therapy, usually requires from four to five years altogether. After this study is completed, the radiologist thus equipped will generally find a position open for him as senior physician in the radiological department of one of the greater hospitals of the country.

The training of teachers in radiology is a very important question. A university teacher in medical radiology should fulfill the same requirements as are made of the teachers in other disciplines; that is, he should be not only a good practician, but should possess a scientific competence proved by independent scientific production, and he should be able to teach.

In a large attendance at institutions for radiological research and instruction lies the only possibility of developing a sufficient staff of teachers in that branch of medical science. Also in the training of teachers an

organized co-operation with correlated medical disciplines is absolutely indispensable. A necessary condition for the development of education in medical radiology on a scientific basis is that the radiological work in the hospitals out in the country be organized to function in an independent and scientific manner. If there is to be any meaning at all in starting and maintaining a system of scientific, special education in medical radiology, there must be established, in connection with those hospitals, radiological departments of such a character that radiological work can be carried out there in a scientific manner, offering the radiologist in charge of such a department an economic situation justifying the long years he has spent in thoroughly fitting himself for the work. At present, the roentgen departments of Swedish hospitals offer for roentgenologists twenty-two situations as physicians in chief, and six more such places are in the course of being established.

If we look back over the history of radiology, we certainly find that many extraneous circumstances have affected its course. But the deeper we study it, the more do we realize that also here—as is the case with every historical development—it is the *personal* forces that have decided the issue right along. The science of radiology has grown up around the ideals visioned by its leaders, and the strongest forces for its development have been their deep attachment to their task and their steadfast faith in the future of their science and in the incalculable services that medical radiology would in ever increasing measure be able to do for mankind.

There is not the slightest doubt but that, in the future, the development of radiology will depend, more than anything else, on the quality of the *men* we shall be able to enlist for our science. Therefore, if we wish and strive for the advancement of that science, our first and most important effort must be to seek our recruits among those of the young generation who give the greatest promise of becoming leaders in scientific work, and win them for the cause of radiology. We must look for and give heed to the interest of the sort of pupils who have the gift of being able to see with their own eyes, and who possess that innate desire for searching deeply into the causes and relations of the phenomena, which we call the scientific instinct—*the scientific mind.* They are the ones we must try to win, and, to accomplish that, education in radiology is our surest means. Our teaching must be such that it will open the eyes of the young to the problems and possibilities here offered them for work and exploration in a new field of useful science, and such as to make them realize that it is a great thing, indeed, to devote one's interest, study, and life-work to medical radiology.

The end which this Congress has in view is to further the development of radiology and to make the results obtained by radiology bear useful fruit for medical science and service. To achieve that end, no means is more effective than a well-organized education in radiology. The great interest with which our invitation has been met shows to what extent the importance of this question is realized everywhere. Twenty-three teachers of radiology from different parts of the world have responded to our invitation to present an account of the manner in which the instruction in medical radiology is organized in their respective countries, and to express their views and wishes as to the manner in which that instruction should be further developed. Not all of them will have the opportunity to present to you here, to-day, a verbal summary of their experiences, but, as will be seen from the program of the Congress, their contributions will all be printed and published together in one instructive volume, which will appear as

soon as possible after the conclusion of the Congress.

We hope that this volume will become a "Golden Book" in the history of radiological education, and will be a lasting source of information and incentive to those teachers and authorities on whom the responsibility rests for the organization and future development of instruction and education in radiology.

THE FOURTEENTH ANNUAL MEETING

Drake Hotel, Chicago, Dec. 3–7, inclusive, 1928

AN INVITATION

Every member of the RADIOLOGICAL SOCIETY OF NORTH AMERICA is expected to take advantage of the many scientific opportunities afforded in CHICAGO by attending this FOURTEENTH ANNUAL MEETING. It is the Society's loss as well as your own if you fail to be present.

The PROGRAM which has been prepared is both SCIENTIFIC and CLINICAL in character and divided into diagnostic and therapy sections and yet the entire field and the most recent advances in radiology have been most carefully covered.

Those who are practising radiology, internal and general medicine, surgery, other specialties and allied sciences are *privileged* and *invited* to attend all of the scientific sessions and exhibits.

Your colleagues and friends, and—most important—the LADIES, are likewise cordially invited and urged to be present by the officers of your Society and the Local Chicago Committee, for the enjoyment of the scientific and social program prepared for them during this annual gathering.

EDWIN C. ERNST, *President.*

PROGRAM

Monday, December 3
8:30 A. M.—12 Noon

Registration

Secure tickets for the Afternoon Demonstration Clinics, 4:00 to 6:00 P. M.

Banquet tickets should be obtained in advance at the Registration desk.

Monday, December 3
Afternoon Session 1:30 P. M.
Opening Meeting

Call to Order............DR. EDWIN C. ERNST
President, Radiological Society of North America

Invocation ....

Welcome in Behalf of the City................

Welcome in Behalf of the Local Profession

Response ....DR. EDWIN C. ERNST
President, Radiological Society of North America

Afternoon Scientific Session

OTTO GLASSER, PH.D., Cleveland Clinic, Cleveland, O.
"A Sketch of the Progress Made in the Knowledge of the X-ray during the Year after Its Discovery."

DR. GUSTAV BUCKY (by invitation), New York City
"Grenz Ray Therapy."

DR. ALBERT BOUWERS (by invitation), Eindhoven, Holland
"Self-protecting X-ray Tubes and Their Influence on the Development of X-ray Technic."

PROF. DR. FRIEDRICH DESSAUER (by invitation), Frankfort, Germany (to be read by Egon Lorenz)
"The Question of the Fundamental Biological Reaction of Radiation."

Monday, December 3
Evening Session, 6:30 P. M.

Counselors' Dinner.........................."Dutch"
Every Counselor is expected to make his annual report.

All members are urged to be present and to offer suggestions in the interest of this Society and their profession, at the Executive Session held immediately after the meeting.

Tuesday, December 4

Morning Session, 9:00 A. M. sharp

Symposium on "Cancer of Uterus and Adnexa"

DR. ALBERT SOILAND, *Leader*, Los Angeles, Calif.

DR. M. J. SITTENFIELD, New York
"Prognosis of Cancer."

DR. FRANCIS CARTER WOOD, New York
"Biological Ionization Chambers."

DR. W. S. LAWRENCE, Memphis, Tenn.
"Standardization of X-ray and Radium Treatment of Carcinoma of the Cervix."

DR. HAROLD SWANBERG, Quincy, Ill.
"Regaud's Technic in Cervical Cancer: Use of New Radium Applicator."

DR. J. THOMPSON STEVENS, Montclair, N. J.
"Carcinomata of the Cervix: Treatment with Radium, Roentgen Rays, and Electrothermic Surgery."

DR. W. A. NEWMAN DORLAND, Chicago, Ill.
"The Value of Radiation Therapy in the Post-operative Treatment of Papillary Cystadenoma of the Ovary."

Tuesday, December 4

Afternoon Session, 1:30 P. M.

DR. ALBERT SOILAND, Los Angeles, Calif.
"The Present Status of Roentgen Therapy in Breast Malignancy."

DR. HENRY SCHMITZ, Chicago, Ill.
"Five-year End-results of Treatment of Carcinoma of the Breast with Surgery and Radiations."

DR. BENJAMIN H. ORNDOFF, Chicago, Ill.
"Radiotherapy and Electrosurgical Practice Combined."

DR. CHARLES A. WATERS, Johns Hopkins University, Baltimore, Md.
"Radiation: Its Uses in the Treatment of Urologic Conditions."

DR. FRED W. RANKIN, Mayo Clinic, Rochester, Minn.
"Surgery in Cancer of the Rectum."

DR. HARRY H. BOWING and Associates, Mayo Clinic, Rochester, Minn.
"Cancer of the Rectum."

Tuesday, December 4

Evening Session, 8:00 P. M.

ILLINOIS NIGHT PROGRAM

DR. M. L. HARRIS, President-elect of the American Medical Association;

DR. FRANKLIN H. MARTIN, President-elect of the American College of Surgeons;

DR. FRANK R. MORTON, President of the Chicago Medical Society.

Subject: "ORGANIZED MEDICINE"

Wednesday, December 5

MORNING PROGRAM

Section "A." Scientific Session 9:00 A. M. sharp

DR. SAMUEL BROWN, Cincinnati, Ohio
"Radiology of the Thorax: A Study of the Thorax in Three Dimensions."

DR. JOHN T. FARRELL, JR., Philadelphia
"The Roentgen Diagnosis of Pulmonary Neoplasms."

DR. I. PILOT, Chicago, Ill.
"Mesenchymatous Tumors of the Lung and Pleura."

DR. R. P. POTTER, Marshfield, Wisc.
"Intrathoracic Tumors: Case Report."

DR. LEON T. LEWALD, New York University, New York City
"Chronic Lung Suppuration: Report of Three Cases of About Ten Years' Duration."

DR. P. R. CASELLAS, Chicago, Ill.
"A Roentgenological Study of the Child's Chest."

Wednesday, December 5

MORNING PROGRAM

Section "B." Scientific Session, 9:00 A. M. sharp

DR. O. M. WALTER, Chicago, Ill.
"Hypoparathyroidism as a Complication of Thyroid Surgery."

DR. JOHN REMER and DR. WEBSTER W. BELDEN, New York Hospital, New York City
"The X-ray Diagnosis and Treatment of Thyroid Disease."

DR. IRA I. KAPLAN, Bellevue Hospital, New York
"X-ray Therapy in the Treatment of Acute Gonorrheal Arthritis."

DR. ERNST A. MAY, Newark, N. J.
"Roentgentherapy in Acute Inflammatory Conditions."

DR. DELLA G. DRIPS and DR. FRANCES A. FORD, Mayo Clinic, Rochester, Minn.
"Clinical and Experimental Studies in Low Dosage Irradiation for Irregularities of Menstruation."

DR. W. C. DANFORTH, Evanston, Ill.
"Treatment of Benign Uterine Hemorrhage by Irradiation."

DR. MARY ELIZABETH HANKS, Chicago, Ill.
"Roentgen Therapy in Fibromyomata and Other Benign Gynecologic Cases: A Clinical Report of Twelve Years' Experience."

DR. E. C. FRANING, Galesburg, Ill.
"Results of Treatment of Fibroid Uteri with Roentgen Ray: A Series of Fifty Cases."

DR. DOUGLAS P. MURPHY, University of Pennsylvania.
"Experimental and Clinical Study Dealing with the Health of Children Born Following Maternal Pelvic Irradiation."

Wednesday, December 5

AFTERNOON PROGRAM

Scientific Session, 1:30 P. M. sharp

The Premier Presentation of a Cinematograph Film of Living Tissue and the Effect of Radium Radiation on the Cells

By DR. R. G. CANTI of London

The showing of this film was one of the special features of the International Radiological Congress Meeting at Stockholm, Sweden, and its presentation here should be seen by every member of the Radiological Society of North America.

Immediately preceding the showing of this film, DR. L. S. TAYLOR of the United States Bureau of Standards will speak on "X-ray Dosage Standardization of the Bureau of Standards"

and

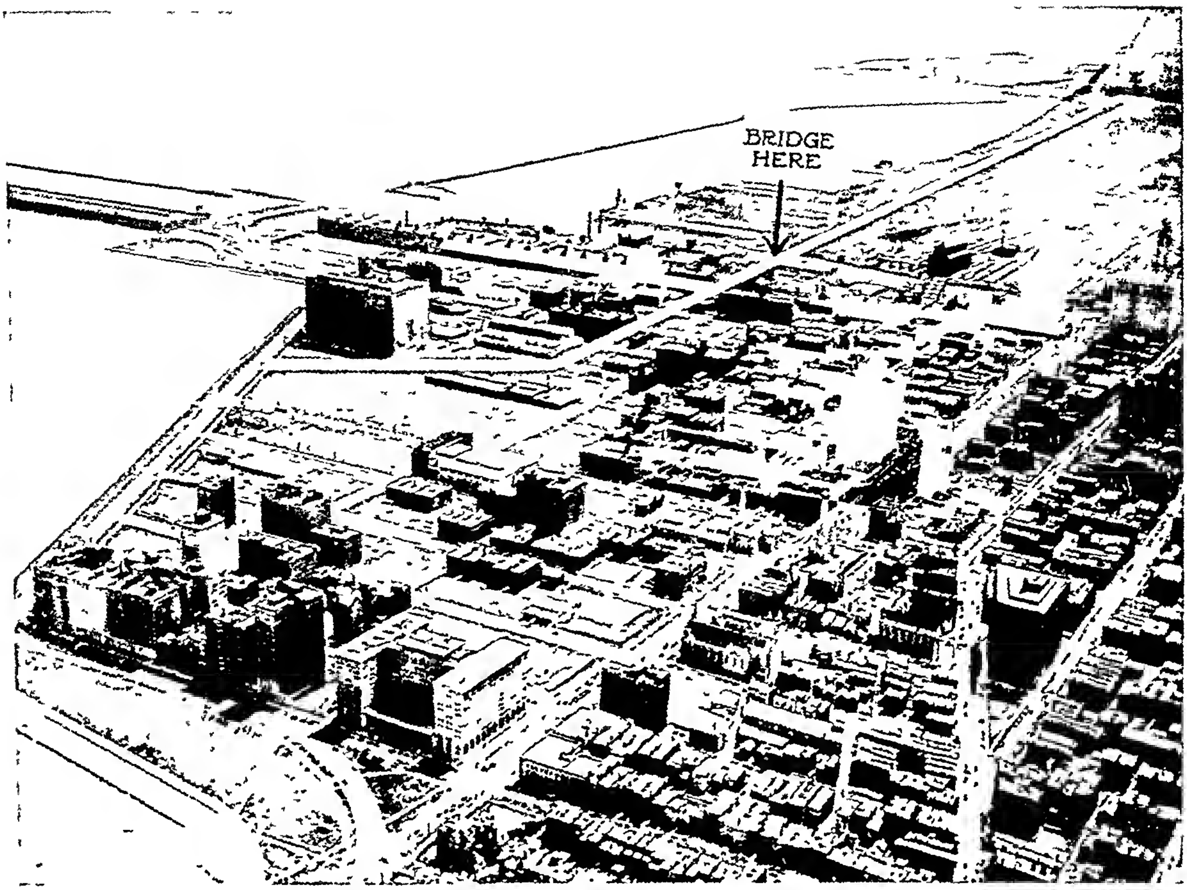
DR. GEORGE A. SOPER, PH.D., New York City, Director of the American Society for the Control of Cancer, will introduce the Canti film with a brief address: "The Present Status of the Cancer Problem."

Wednesday Evening, December 5

Scientific Session, 8:00 P. M.

CHICAGO NIGHT PROGRAM

The speakers on the Chicago Night program will be Prof. Arthur H. Compton, of the University of Chicago, whose subject will be "Some Physical Effects of X-rays," and Dr. William T. Bovie, of Northwestern University, who will speak on "The Stuff We are Made of," illustrated by lantern slides. The addresses will be followed by a smoker and stag entertainment.



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Airplane view (the modern form of "the bird's-eye view") of the Drake Hotel and the Lower North Side district of Chicago The white line and the arrow indicating "Bridge here" are of the future rather than of the present, since they show where the new boulevard link is to be located. Since this photograph was taken the splendid Northwestern University buildings of Medicine, Dentistry, Law, and Commerce have been built about McKinlock Campus, shown here as the vacant blocks on the Lake Front The Drake Hotel, where the Annual Meeting of the Society is to be held during the first week of December, is the double-T shaped building in the immediate foreground It is located on Michigan Avenue, the straight route to the Loop, whose gateway is marked by the *Tribune* Tower and the Wrigley Buildings, on the extreme right of the picture.

Thursday, December 6

MORNING PROGRAM

Section "A" Scientific Session, 9:00 A. M sharp

DR. J. NEWTON SISK, Madison, Wisc.
"Bone Tumors"

DR. M. A BERNSTEIN, Chicago, Ill.
"Metastatic Invasion into Synovial Membranes and Bones"

DR. EDWARD T EVANS, Minneapolis, Minn.
"Osteitis Fibrosa Polycystic, Monocystic and Diffuse."

DR. MALCOLM B. HANSON, Minneapolis, Minn.
"Healing in Bone Tuberculosis."

DR. ROBERT B. TAFT, Charleston, S. C.
"A Review of Osgood-Schlatter Disease."

DR. WILBUR H. GILMORE, Chicago, Ill.
"Fractures of the Pelvis."

DR. HOWARD P. DOUB, Detroit, Mich.
"Report of a Hip Condition of Undetermined Etiology."

Thursday, December 6

MORNING PROGRAM

Section "B." Scientific Session, 9:00 A. M. sharp

Symposium on: "Cancer Therapy, with Special Reference to Relative Radiosensitivity of Tumors."

Dr. Douglas Quick, *Leader*, Memorial Hospital, New York City

G. Failla, D.Sc.

"Measurement of X-ray Dosage by Physical Means."

Edith H. Quimby, M.A., and George T. Pack, M.D.

"The Skin Erythema for Combinations of Gamma- and X-rays."

Dr. James Ewing

"Radiosensitivity and Selective Action of Different Types of Radiation."

Dr. Frank Adair

"The Response of Various Types of Breast Cancer to Radiation."

Dr. William P. Healy

"Variation in Radiosensitivity of Epidermoid Carcinomas of the Cervix Uteri."

Dr. R. E. Herendeen

"Radiation in Primary and Metastatic Bone Tumors."

Dr. Hayes E. Martin

"Interstitial Radiation."

Thursday, December 6

AFTERNOON PROGRAM

Section "A." Scientific Session, 1:30 P. M.

Dr. C. B. Rose, Chicago, Ill.

"Some Unusual X-ray Findings in Skulls."

Dr. John A. Beals, Jacksonville, Florida

"An Intracranial Calcification, Probably of Choroid Plexus."

Dr. Fred Hodges, Madison, Wisc.

"The Diagnostic Department of a General Hospital."

Dr. W. Walter Wasson, Denver, Colo.

"The Incipiency of Disease."

Thursday, December 6

AFTERNOON PROGRAM

Section "B." Scientific Session, 1:30 P. M.

K. Wilhelm Stenstrom, Ph.D., Minneapolis, Minn.

"Effect of Roentgen Radiation on Certain Chemical Compounds: (*A*) Tyrosine and Cystine; (*B*) Cholesterol; (*C*) Acetylene and Propane."

Dr. V. M. Moore, Grand Rapids, Mich.

"Radiation Sensitization, with Case Report."

Dr. R. T. Pettit, Ottawa, Ill.

"The Use of Small Amounts of Radium at a Distance in the Treatment of Carcinoma of the Mouth and Face."

Dr. Alden Williams, Grand Rapids, Mich.

"A Report of Technic and Results in Treatment of Five Hundred Superficial and Borderline Malignancies, Including a Group of Eighty-five Lip Cases."

Dr. Max Kahn, Baltimore, Maryland

"On the Question of Pre- and Post-operative X-ray Treatment of Breast Carcinoma."

Thursday Evening, December 6

7:00 P. M.

THE ANNUAL BANQUET

Presentation of the Society's Gold Medal to Prof. Arthur Compton

Presentation of Gavels to the Past Presidents

Address by the President

Among the additional speakers present will be the Hon. Louis Emmerson, Secretary of State of Illinois and Governor-elect

Entertainment: Dancing

Friday, December 7

MORNING PROGRAM

Section "A." Scientific Session, 9:00 A. M. sharp.

Dr. P. B. Goodwin, Peoria, Ill.
"Diverticulum of Esophagus, with Report of Case."
Dr. P. M. Hickey, Ann Arbor, Mich.
"A Method for Measuring the Lumen of the Esophagus."
Dr. Richard Hayes, Longview, Wash.
"Intermittent Duodenal Stenosis."
Dr. B. R. Kirklin, Mayo Clinic, Rochester, Minn.
"A Roentgenologic Consideration of Duodenitis."
Dr. William J. Cassidy, Detroit, Mich.
"Critical Evaluation of What the Roentgenologist Visualizes *vs.* What the Surgeon Demonstrates in Gastric or Duodenal Ulcers."
Dr. Maurice F. Dwyer, Seattle, Wash.
"Interpretation of Gastric Symptoms: A Clinical and Roentgenological Study of 3,500 Cases."
Dr. George H. Caldwell and
Dr. A. W. Crane, Kalamazoo, Mich.
"The Influence of Phenolphthalein on Intestinal Movements."
Dr. Karl Kornblum, Philadelphia
"The Significance of Small Intestinal Stasis."

Friday, December 7

MORNING PROGRAM

Section "B." Scientific Session, 9:00 A. M. sharp.

Symposium on: "Ultra-violet Light."
Dr. A. U. Desjardins, *Leader*, Mayo Clinic, Rochester, Minn.
Dr. Clarence L. Hyde, East Akron, Ohio
"The Value of the Carbon Arc as a Source of Ultra-violet for General Irradiation."
Dr. William T. Anderson, Jr., Hanovia Chemical and Manufacturing Company
"The Quartz Mercury Arc Lamp."
Dr. Edgar Mayer, Saranac Lake, N. Y.
"Conclusions of Ten Years' Observations upon the Use of the Mercury Vapor Arc Irradiations in Tuberculosis."
Dr. E. D. Crutchfield, San Antonio, Texas
"The Combined Effect of X-rays and Ultra-violet Light (An Experimental Study) on Laboratory Animals."
Dr. Heuer, Professor of Surgery, University of Cincinnati
Subject to be announced.
Prof. William T. Bovie, Northwestern University
"Radiology and the Living Cell."

Friday, December 7

AFTERNOON PROGRAM

Section "A." Scientific Session, 1:30 P. M.

Dr. Fred M. Hodges, Richmond, Va.
"The Roentgen Ray in the Diagnosis of Mucous Colitis."
Dr. Sidney A. Portis, Chicago, Ill.
"The Clinical Significance of Roentgenological Findings in the Right Upper Abdominal Quadrant."
Dr. W. M. Storey, Madison, Wisc.
"A General Use of Radiology of the Teeth, Mouth, and Jaws as a Means of and Aid to Diagnosing Systemic Disease."
Dr. C. S. Oakman, Muncie, Ind.
"The Significance of a Faint Shadow in Cholecystography."
Dr. James T. Case, Battle Creek, Mich.
"Reactions to the Use of Tetraiodophenolphthalein and Similar Salts for Cholecystography."

Friday, December 7

AFTERNOON PROGRAM

Section "B." Scientific Session, 1:30 P. M.

DR. JOHN J. BURBY, Madison, Wisc., and DR. M. W. BARRY, Omaha, Nebr.
"Comparative Measurements of the Quality of Roentgen Rays."

A. MUTSCHELLER, PH.D., Long Island City, N. Y.
"Determination of the Quality Average of the Continuous X-ray Spectrum."

LAURISTON S. TAYLOR, Bureau of Standards.
"Source of Deviations in the Common Standard Ionization Chambers."
"Dosage Unit for Cathode Rays in Air."

J. L. WEATHERWAX, M.A., and DR. B. P. WIDMANN, Philadelphia
"Physical Factors in Radiation Therapy and Their Clinical Application."

DR. P. M. HICKEY, Ann Arbor, Mich., and DR. E. A. POHLE, Madison, Wisc., with the collaboration of G. A. LINDSAY, PH.D., and DR. J. M. BARNES, Ann Arbor, Mich.
"Skin Tolerance Doses in Roentgen Units and Their Relation to the Quality of Radiation."

OTTO GLASSER, PH.D., and DR. U. V. PORTMANN, Cleveland Clinic, Cleveland, O.
"The Reliability of the 'r' Unit for the Measurement of Roentgen and Radium Radiation."

The plans concerning clinics embrace the following:

Tuesday, December 4, 4 to 6 P. M.: Dr. D. B. Phemister, Bone Pathology; Dr. D. N. Eisendrath, Urology; Dr. A. W. Proetz and Dr. Edwin C. Ernst, Clinical Demonstration of Lipiodol Diagnosis in Sinus Disease by the Displacement Method.

Wednesday, December 5, 4 to 6 P. M.: Dr. Emil Beck, Cancer Problems; Dr. E. S. Blaine, Interpretation; Dr. William T. Bovie, Physiotherapy; Dr. Irving F. Stein, Pneumoperitoneum.

Thursday, December 6, 4 to 6 P. M.: Dr. Joseph C. Bloodgood, Periosteal Neoplasms; Dr. A. C. Ivy, Physiology of the Gall Bladder. These clinics will be held at the Northwestern University School of Medicine.

Friday, December 7, 4 to 6 P. M.: Dr. Joseph C. Bloodgood, Osseous Neoplasms; Dr. Percy Bailey, Ventriculography; Dr. Temple Fay, Ventriculography.

Other clinics, as yet unassigned as to date, are expected to be held by Dr. L. A. Crandall, Serous Membrane Reactions to Lipiodol; Dr. C. E. Cook, Chest Diagnosis; Dr. Carl A. Hedblom, Chest Surgery; Dr. Kennon Dunham, X-ray Chest Clinic.

Tickets will be issued at the Registration Desk for admission to the clinics, and only a number that can see and hear to advantage will be admitted. The room secured for Dr. Bloodgood's clinics will accommodate a large number of listeners.

During the month of December, 1928, the Liebel-Flarsheim Company, of Cincinnati, Ohio, expects to remove to a new building, Third and Plum streets, where both their works and office will be housed. Physical therapy apparatus will in the future more wholly engage the activities of this company.

REPORT OF THE INTERNATIONAL X-RAY UNIT COMMITTEE

During the recent meeting of the Second International Congress of Radiology, held in Stockholm, Sweden, July 23 to 27, 1928, the Convenor of the International X-ray Unit Committee, E. A. Owen, called to order the International X-ray Unit Committee for the purpose of discussing and perhaps reaching an agreement regarding the standardization of X-ray measurements. Two delegates had been appointed by each of the following countries to attend this meeting, one a physicist and one a radiologist, representing, respectively, Austria, Belgium, Bulgaria, Czecho-Slovakia, Denmark, France, Germany, Great Britain, Greece, Holland, Hungary, Italy, Japan, Norway, Russia, Spain, Sweden, Switzerland, and the United States of America.

The report of the Standardization Committee of the Radiological Society of North America, made at New Orleans in 1927, is fundamentally similar to the one recommended by this International X-ray Unit Committee, as follows:

The International X-ray Unit Committee has come to unanimous agreement regarding the standardization of X-ray measurement, and forwards to the Meeting of the Delegates of the Second International Congress of Radiology the following proposals for endorsement and promulgation:

(1) That an International Unit of X-radiation be adopted.

(2) That this International Unit be the quantity of X-radiation which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in one cubic centimeter of atmospheric air at 0° C. and 76 cms. mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current.

(3) That the International Unit of X-radiation be called "The Roentgen" and that it be designated by the letter small "r."

(4) That various standard methods be employed to establish the unit.

(5) That for all comparative purposes it is advisable to employ ionization chambers which have been calibrated in terms of a standard chamber for X-radiation of the various qualities employed. It is also advisable to make the wall effects of these chambers as small as possible.

(6) That the practical instrument used to measure X-ray output be called a dosage-meter (*Dosismesser, dosimètre*).

(7) That the constancy of the indications of the dosage-meter be tested by means of gamma radiation emitted from a definite quantity of radium element, the measurement being carried out always under the same conditions.

(8) That any specification of dosage is incomplete without specifying the quality as well as the quantity of the radiation. The quality of X-radiation used for practical purposes varies widely and it would be impracticable to give a complete specification of it, but much information can be obtained from a knowledge of the degree of absorption of the radiation in standard materials, the peak voltage applied to the tube together with the filter employed, and the general character of the high tension apparatus.

For practical purposes the quality may be expressed by stating the half value layer in a suitable material, or by stating the effective wave length as determined by the percentage amount of radiation transmitted through a given thickness of a suitable material (copper or aluminium).

In view of the fact that rapid progress is being made in methods of X-ray measurements and in our knowledge of X-ray phenomena, the Committee feels that the above

recommendations should be regarded as being of a provisional character.

MANNE SIEGBAHN, *Chairman.*
E. A. OWEN } *Honorary*
H. HOLTHUSEN } *Secretaries.*

Stockholm, Sweden
July 25, 1928.

The above report is respectfully submitted for publication.

WILLIAM DUANE, PH.D.
EDWIN C. ERNST, M.D.
Representatives to the International X-ray Unit Committee

COMMUNICATION

CONCERNING THE COMMERCIAL EXHIBIT

To the Members of the Radiological Society of North America:

I wonder if you are fully appreciative of the enormous amount of help that the exhibitors in the Commercial Exhibits have been to our Society.

If you have supposed that the Society, its journal, its meetings, and its numerous other activities could be maintained solely from your dues paid into the treasury, it is because you have not paused to consider.

Up to the end of the coming meeting in Chicago, the commercial exhibitors will have contributed a sum considerably in excess of $30,000 for exhibit space at the twenty-two meetings of the Society, every dollar of which has gone toward paying some of the Society's expenses. You have in some way or other received benefit from that $30,000, and it is my suggestion that you show your appreciation by visiting every exhibit at the Drake Hotel during the coming meeting. See every exhibit and tell every exhibitor that you appreciate his co-operation. Tell all of the exhibitors that we want them to continue to help us, and show them by your words and actions that you share in the Society's appreciation of their long continued interest and support.

The following 27 firms have bought space in the Drake Hotel Commercial Exhibit:

Abbott Laboratories, North Chicago, Ill.
Acme-International X-ray Co., Chicago
Geo. W. Brady & Co., Chicago
Britesun, Inc., Chicago
Buck X-Ograph Co., St. Louis, Mo.
Cameron's Surgical Specialty Co., Chicago
Chicago X-ray Film & Mount Co., Chicago
Cooper & Cooper, Inc., New York City
Davies, Rose & Co., Ltd., Boston, Mass.
Eastman Kodak Company, Rochester, N. Y.
Engeln Electric Company, Cleveland, O.
French Screen Company, Detroit, Mich.
General X-ray Company, Boston, Mass.
Hanovia Chemical & Mfg. Co., Newark, N. J.
Horlick's Malted Milk Corporation, Racine, Wis.
Kelley-Koett Mfg. Co., Inc., Covington, Ky.
Medical Protective Co., Chicago
Middlewest Instrument Co., Chicago
National Aniline & Chemical Co., Inc., New York City
Patterson Screen Co., Towanda. Pa.
Picker X-ray Corporation, New York City
Radiographscope Co., Greensboro, N. C.
Standard X-ray Company, Chicago
Swan-Myers Company, Indianapolis, Ind.
Victor X-ray Corporation, Chicago
Waite & Bartlett Mfg. Co., Long Island City, N. Y.
Wappler Electric Company, Long Island City, N. Y.

I am sure that all will agree that the above list represents the good, the modern, and the up-to-date in American products of interest to American radiologists. *See every exhibit. Talk with all the exhibitors. Tell them that they have "put it over" handsomely.*

Yours for success,
I. S. TROSTLER, M.D.

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McCutchen Portable X-Ray Fracture Device

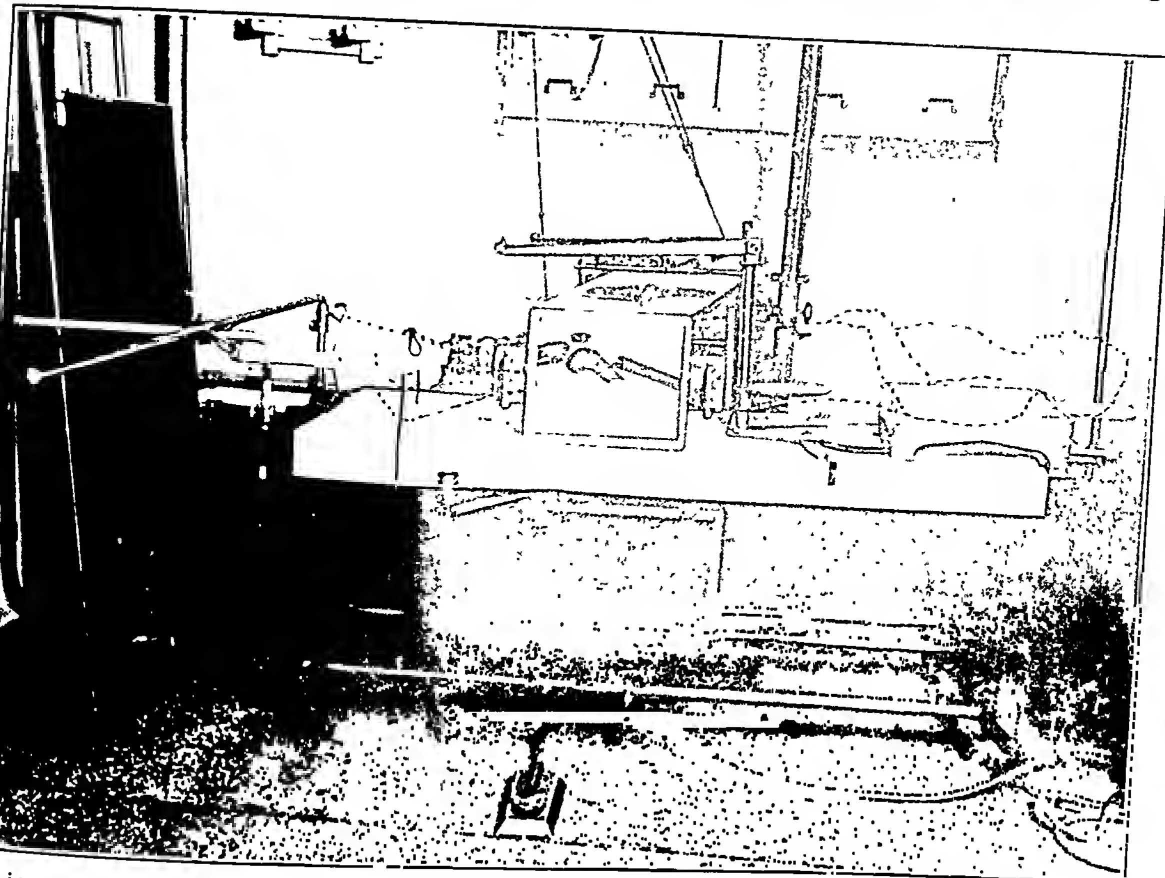

Fig. 3. Biplane view. Both tubes energized at same time. Tube under table for anterior-posterior view; tube rotated
side for lateral view. Two fluoroscopic screens placed at right angle. Traction is made by lever while under fluoroscopic
on. (Time interval must be watched closely on account of double exposure.)


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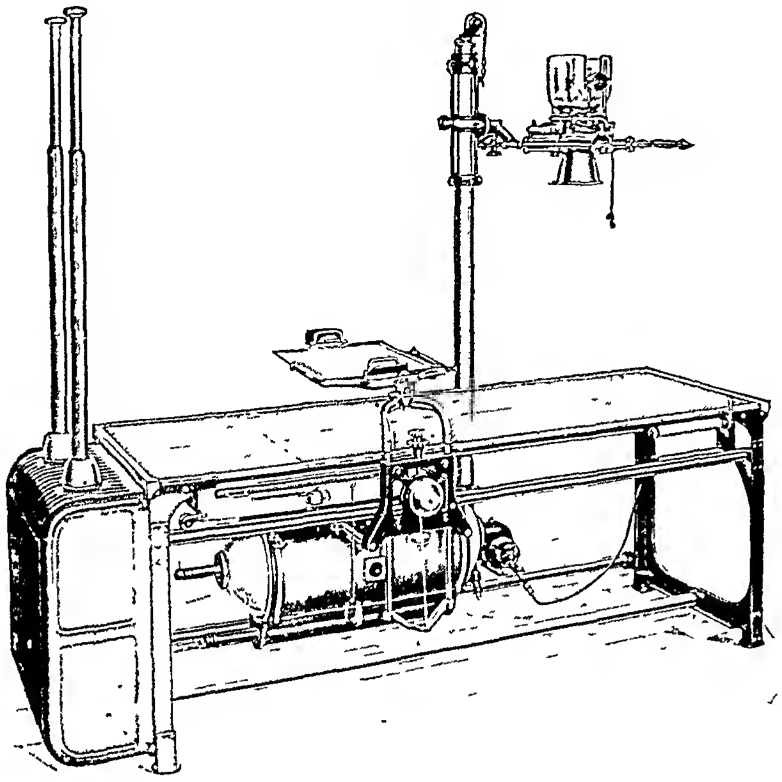

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EVER alert and constantly in quest of new and and improved devices that may assist the Roentgenologist toward still greater achievenents in his work, Acme-International X-Ray Compány offers the No. 5 Flat Fluoroscopic Bucky Table.

The perfectly flat top, made possible by the use of an ingenious method of support, will instantly appeal o the discriminating X-ray user—for it provides absolute rigidity and a minimum patient-film distance.

This table is regularly furnished with the No. 2 Tube Stand, which is counter-balanced on a large nickel-plated column, and mounted on a side rail unit of solid steel bar.

The Precision Flat Potter-Bucky Diaphragm, equipped with ratchet compression device and electric attachment for connection to the x-ray circuit breaker, is mounted on ball-bearing rollers and travels the entire length of table.

Genuine bakelite insulators in the fluoroscopic mast unit afford complete immunity from electrical shock. The use of a lead fluoroscopic tube holder protects against harmful x-radiation. The tube holder is ball-bearing mounted and travels the entire length of the table.

The fluoroscopic screen is 12" x 16", adjustable for height by means of a spring counter-balance, and is always centered with the tube.

[Illustrated and descriptive literature gladly sent upon request]

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